# Hemodialysis Abstracts from the 23rd Annual Dialysis Conference

## 23rd Annual Conference on Peritoneal Dialysis, 9th International Symposium on Hemodialysis, and 14th Annual Symposium on Pediatric Dialysis

**Seattle, Washington**
**March 2–4, 2003**

## To Maximize the Creation of A.V. Fistulas: The Kaiser Way

First described by Brescia and Cimino in 1961 the A.V. fistula remains the best form of permanent vascular access. 24 to 27% of A.V fistulas thrombose within the first few postoperative weeks or fail to achieve sufficient caliber to permit cannulation. Most mature between two to six months. Once mature native fistulas have excellent long-term patency rates and rarely become infected. A.V. fistulas can provide adequate vascular access for over 20 years. The importance of careful preparation for A.V. fistula placement months before the need for hemodialysis cannot be over-emphasized.

*Planning the Kaiser way*: Planning starts with the primary physician, screening the patients at risk: over 60 years old, diabetes mellitus, hypertension. The primary physician refers the patient to the nephrologist and renal team if the Cr. is 1.5 or higher for a female or 2.0 or higher for a male. During the early stages of the kidney disease, pre-ESRD, the patient will be referred to the Choices Class to learn the different modalities (hemodialysis, peritoneal dialysis, and transplant issues). Once the nephrologist makes the decision that the patient will be on hemodialysis in the future, the patient is referred to the Renal Case Manager (RCM); he/she will initiate a referral to vascular surgery for evaluation of access placement. The RCM explains to the patient about the first surgical visit with the vascular surgeon, follows with surgery to be sure the appointment is made. When the access is placed, the RCM will do post surgical teaching on how to care for the new fistula. The patient will be followed, including the A.V. fistula, until the patient needs dialysis. If the fistula is not developing well, the RCM will notify the vascular surgeon for evaluation. Once the patient is ready for dialysis the patient is referred to the dialysis center. The RCM will follow up with the dialysis center and see how the access is working. If the fistula is questionable to use, the patient is first dialyzed as in-patient to evaluate the access.

*Oscar Cairoli*, Kaiser Permanente, Bellflower, CA, USA.

## Preliminary Results from the Use of New Vascular Access (Hemaport) for Hemodialysis

One of the most important factors for an optimal chronic hemodialysis is a well- functioning vascular access. Still the A-V-fistula is the best alternative. When repeated failures arise new access alternatives are needed. The Hemaport combines a PTFE-graft with a percutaneous housing of titan. Starting and stopping the dialysis session is simple and needle-free. The first clinical experiences are presented.

Thirteen patients (m-age 60 years) in 6 centres had used the Hemaport system. Out of 11 functioning devices 7 were placed on the upper arm and 4 were located on the thigh. The total days in observation were 2.156 days with 769 dialysis sessions performed. Six patients had used the Hemaport system for more than 6 months. Mean blood flow was 364, range 100–450 ml/min with a mean venous and arterial pressure of 100 mm Hg, range 30–250, and 16 mm Hg respectively, range $-140$ to $+259$.

Thrombosis interventions have been required in 14 percent to obtain a functioning vascular access. Two patients contributed with more than half of these events. Mechanical or pharmacological thrombolysis can be performed through the Hemaport dialysis lid without open surgery. Six implants have been removed and in 5 of these cases a new Hemaport was implanted. The reasons for removing the device were related to insufficient vascular flow, thrombosis, and/or infection.In patients with repeated access problems, a new vascular access (Hemaport) has been clinically used for about 1 year. By its design, Hemaport offers a novel approach.

*Ahlmén J*[1], Goch J[2], Wrege U[3], Larsson R[4], Honkanen E[5], Althoff P[6], Danielson BG[7]. [1]The Departments of Renal Medicine, Skaraborgs Hospital, Skövde, [2]Visby Hospital, [3]Gävle-Sandviken Hospital, [4]University of Linköping, Sweden, [5]University of Helsinki, Finland, [6]Västerås Hospital in cooperation with [5]Hemapure AB, Uppsala, Sweden

## Bactericidal Properties of Acidified (pH 2.0), Concentrated (27%) NaCl (ACS), a Potentially Useful Agent for Locking Hemodialysis Catheters

Between dialyses, the catheter lumens are commonly locked with heparin (H), which does not prevent bacterial growth. Trisodium citrate (TSC) has been used as a locking agent because of its anticoagulant effects and suggested bactericidal properties. The purpose of this study was to evaluate the bactericidal properties of ACS as a potential locking agent in the air-bubble locking method (Twardowski ZJ et al. Air-bubble method of locking central-vein catheter: A pilot study. Hemodial Int. Abstracts, 2003; 7: this issue). ACS does not induce formation of resistant strains, and is harmless if a small amount (0.5–1.5 ml) is incidentally injected. Other bactericidal agents, such as Chlorhexidine (Ch), povidone iodine (PI), TSC, and sodium hypochlorite (SH) are harmful if incidentally injected.

Bactericidal properties of ACS were compared to 27% NaCl, normal saline (NS) bacteriostatic NS (BNS), 1% SH, 0.057% SH, 46% TSC, 23% TSC, H 5000 units/ml, H 10,000 units/ml diluted with BNS to 5000 units/ml, 4% Ch, and 10% PI. Effects on 8 organisms were studied: *S. aureus*, penicillin and methicillin resistant *S. aureus, S. epidermidis, K. pneumoniae, P. aeruginosa, E. coli*, and *C. albicans*. The organisms were prepared following the manufacturers' protocols with a final concentration of $10^7$–$10^8$ cfu/ml for bacteria and $10^4$–$10^5$ cfu/ml for yeast. Following standard microbiological technique, a 10-$\mu$l loop of preparation was added to 1 ml of each of the solutions. A sample of each solution was removed and plated at 0, 1, 3, 6, 24, 48, 72, and 96 hrs. All plates were subsequently counted 24 hrs after plating. Eight to eleven samples of each organism were tested on each solution.

ACS, PI, 0.057% SH, and Ch, killed bacteria in 90%, 69%, 68%, and 61%, of samples immediately (at 0 hr); 100% of samples from these solutions showed no growth at 24 hrs. Only 1–5% of samples from other solutions showed no

growth at 0 hr. All samples from BNS and 1% SH showed no growth at 24 hrs; samples taken from other solutions showed growth in 17–68% samples at 24 hrs. The percent of sterile samples taken from the latter solutions gradually increased with time, probably due to lack of nutrients.

We conclude that ACS may be useful as a bactericidal agent for the air-bubble method of central-vein catheter locking. Bactericidal properties of 46% and 23% TSC were not confirmed in this study.

*Moore HL*, Twardowski ZJ. Division of Nephrology, Department of Medicine, University of Missouri, Columbia, Missouri, USA.

## Air-bubble Method of Locking Central-vein Catheters: A Pilot Study

The major source of catheter-associated bacteremia is contamination of the catheter hub during connection-disconnection procedures. Between dialyses, the catheter lumens are commonly locked with heparin (H), which does not prevent bacterial growth. Prophylactic use of antibiotics mixed with H reduces bacteremic episodes, but risks the development of antibiotic-resistant strains of bacteria. A new method of catheter locking has been developed (U.S. Patent 6,423,050), wherein anticoagulant is injected first, followed by 0.1 ml air bubble, and a bactericidal solution. The anticoagulant is then located at the catheter tip, where clotting is a problem, and the bactericidal solution is located at the catheter hub, where bacterial contamination is common. The air bubble prevents mixing of the two solutions.

A feasibility study has been conducted using H 5,000 units/ml as the anticoagulant, and acidified (pH = 2.0) concentrated (27%) NaCl (ACS) as the bactericidal solution (Twardowski ZJ and Moore HL. Bactericidal properties of acidified (pH 2.0), concentrated (27%) NaCl (ACS), a potentially useful agent for locking hemodialysis catheters. Hemodial Int. Abstracts, 2003; 7: this issue). Ten patients were randomized, either to H lock (5 patients, 62 treatments) or air-bubble method (5 patients, 56 treatments). In the control group the catheters were locked with H according to the capacity provided by the manufacturer with 0.1 ml overfill. In the experimental group, the catheters were locked with H (amount varied according to catheter fill volume), 0.1 ml air bubble, and 0.9 ml ACS. Altogether, the lumen was overfilled by 0.1 ml. According to calculations, an incidental, rapid injection of 0.1 ml air is harmless and rapid injection of up to 1.5 ml of ACS would not perceptibly affect blood pH and/or osmolality in the superior vena cava. The study was approved by the Institutional Review Board of the University of Missouri.

There were no problems with locking of the catheters. There were no episodes of bacteremia in either group, except for one case associated with purulent drainage from the exit and same organism in both cultures. In three instances in each group, the locking solution could not be aspirated and was injected without any subjective symptoms or objective signs.

We conclude that the air-bubble method of locking central-vein catheters is safe, and a full-scale prospective randomized study is feasible.

[1] *Twardowski ZJ*, [2] Reams G, [1] Prowant BF, [1] Moore HL, [2] Van Stone JC. [1]Division of Nephrology, Department of Medicine, University of Missouri, and [2]Dialysis Clinic Incorporated, Columbia, Missouri, USA.

## The Cost of Vascular Access Infections: Three Years Experience from a Single Outpatient Dialysis Center.

Vascular access care accounts for a third of ESRD cost and is a leading cause of morbidity in hemodialysis (HD) patients. We designed this study to identify the risk factors for vascular access infection and to determine the cost of related hospitalizations.

*Methods*: All HD patients at DCI Oakland from 1/1/99 to 6/30/02 were prospectively studied for access type, infections (Infx) including bacteremia, exit site, tunnel or cellulitis, and related hospitalizations. Cost data was obtained from the inpatient electronic medical record system. Risk factors for infection were evaluated using Poisson regression analysis, and cost comparison was done using ANOVA.

*Results*: 153 patients were included in the analysis and were grouped by type of access: temporary catheter (TC) n = 84, permanent/tunneled catheter (PC) n = 158, AV graft (AVG) n = 87 and AV fistula (AVF) n = 57. Univariate analysis revealed significant risk factors to be female gender ($p = 0.004$, RR = 1.85) and type of access. In multivariate analysis, compared to AVF, risk of infection was highest with TC ($p < 0.001$, RR = 44), followed by PC ($p < 0.001$, RR = 17) and AVG ($p = 0.03$, RR = 3). Age, gender, and diabetes were not predictors of infection. The cost per hospitalization in the PC vs. AVG groups was not significantly different.

| *Access type* | *TC* | *PC* | *AVG* | *AVF* |
|---|---|---|---|---|
| # Infx/1000 access days | 5.0 | 3.8 | 0.6 | 0.1 |
| % Infx requiring hospitalization | 12.5 | 12.2 | 58.0 | 60.0 |
| Cost/hosp. admission (mean) | $16,896 | 25,683 | 9,016 | 5,650 |

*Conclusions*: Catheters are associated with much higher vascular access infection rates when compared to fistulas and grafts. When AVFs or AVGs do become infected, they are more likely to require hospitalization. Infections severe enough to require hospitalization result in similar inpatient cost per admission regardless of access type; however, this may be due to small sample size.

*Burr R*, Marszalek J, Saul M, Shields M, Aslam N. University of Pittsburgh Medical Center Health System and VAPHCS, Pittsburgh, PA, USA.

## Blood Pump Speed, Recirculation, and Urea Clearance in Hemodialysis Patients with Dysfunctional Catheters

Urea clearance varies with dialysis blood pump speed (Qb) for well-functioning hemodialysis (HD) catheters. Patients with dysfunctional HD catheters often have reduced Qb due to catheter thrombosis, fibrin sheath, or central venous stenosis. One method of achieving higher Qb is to reverse the position of the HD lines (i.e., connect the arterial line to the venous port and vice versa). However, line reversal is associated with greater catheter access recirculation (AR) and resultant decreased urea clearance.

***Objective***: To determine the effect of line reversal with varying Qb on % AR, and urea clearance in HD patients with dysfunctional.

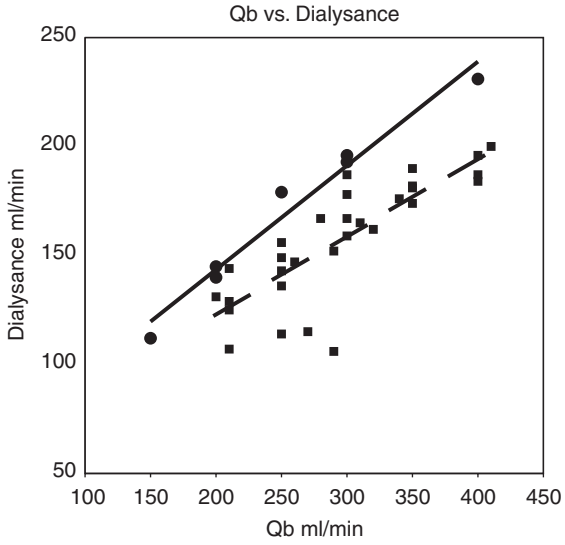
***Methods***: 7 patients with dysfunctional internal jugular catheters in our HD unit were identified. During a regularly scheduled HD session, we measured each patient's on-line urea clearance using dialysance (Diascan) at the maximum achievable Qb with the lines in the normal position, and at varying Qb with the lines in reversed position.

With lines in the reversed position at Qb of 200, 300 and 400 ml/min, dialysance was 123, 159, and 195 ml/min respectively (figure).

***Conclusions***: Line reversal is associated with significant AR in patients with dysfunctional catheters. However, in patients with dysfunctional HD catheters in whom the maximum achievable Qb is $\leq 200$ ml/min in the normal position, greater urea clearance can be achieved by line reversal and increasing Qb to $\geq 300$ ml/min.

Dialysance was used as a surrogate measurement of urea clearance. AR was also measured using ultrasound dilution technique. (Transonic machine) Linear regression was used to model the relationships between Qb, dialysance and AR.

***Results***: AR in dysfunctional IJ catheters with lines in the normal position was 0% for all Qb in the range 150–400 ml/min. According to the regression model, AR with lines in the reverse position was 19% at Qb 300 ml/min. Maximum achievable dialysance with lines in the normal position for Qb $\leq 200$ ml/min was 144 ml/min.




*R.C. Carson*, J. Macrae, M. Kiaii, Dept of Nephrology, St. Paul's Hospital, Vancouver BC, Canada.

## Survival of Vascular Access in Daily Dialysis (DHD)

One of the most feared problems in DHD is the risk of vascular access failure, so that it often limits the diffusion of this technique. Available data are limited; moreover, in most cases data regard home hemodialysis (HHD) patients, with the problem of the risk of a selection bias.

The aim of the study was to evaluate the number of fistula complications (occlusion, infections, necessity of surgical treatment, angioplasty or urokinasi) in two groups of patients either on a DHD or on other dialysis schedules, in patients at home or in Limited Care Center.

In the period considered (total period about 1500 patient-months; HHD: non DHD 463, DHD 278 months; Limited Care Center: non DHD 613, DHD 140 months) we registered 37 events (12 with vascular access occlusion, 11 with necessity of surgical treatment, 14 with necessity of other intervention, angioplasty or urokinasi). In particular, we registered 23 events in HHD (18 non DHD, 6 with vascular access occlusion and 5 DHD, 3 with vascular access occlusion, respectively 4/100 and 2/100 patient-months), 14 events in Limited Care Center (8 non DHD, none with vascular access failure and 6 DHD, 3 with vascular access failure, respectively 1/100 and 4/100 patient-months). Survival curves according to Kaplan-Meier didn't show significant differences for DHD group; a worse survival was shown for HHD patients. In a Cox-proportional hazard model history of previous vascular episodes and HHD were independent risk factors (RR 2.01, 95% CI 1.06–3.83 and RR 1.98, 95% CI 1.15–3.39 respectively; overall score 0.04), while a protective role for male sex was present (RR 0.54, 95% CI 0.30–0.96). In conclusion: The increased number of punctures in DHD didn't cause, in our study, an increase in the risk of vascular access occlusion. The surprise was the disadvantage of HHD compared to dialysis in Limited Care Center, contrary to all expectations. Results from this observational study will be study in depth (relationship with previous vascular problems, hypotension, body weight loss, biochemical risk factors, dialysis efficiency) and for a more prolonged period.

*Bermond F*, Burdese M, Quaglia M, Mezza E, Gai M, Soragna G, Jeantet A, Segoloni GP, Piccoli GB. Department of Nephrology, University of Turin, Italy.

## A Comparison of CV-Catheters (CV) Grafts (GR) and Fistulae (FI) in Quotidian Hemodialysis

We studied longevity and complications from CV, GR, and FI in 23 patients on quotidian hemodialysis. There were a total of 409 patient months, mean 18–10 months observation

and a total of 9209 dialyses. There were 14 FI, 5 GR and 4 CV. 1, 1 and 2 replacements were necessary during a total observation time of 254, 105 and 50 patient months, respectively. For fistulae there were 0.02 replacements/year vs. 0.30 for GR and 0.41 for CV. $P = 0.042$ FI vs. other. The cumulative survival at 15 months was 100% for FI, 80% for GR and 20% for CV. $P = 0.041$. The cumulative survival at 3 years were 80% for fistulae and grafts, no CV lasted beyond 15 months. $P = 0.013$. There were 27 events requiring hospitalization or outpatient intervention. FI: 0.42/patient year, GR 1.22/patient year and CV 1.36/patient year. $P = 0.080$, FI vs. Other. Patients reported more problems between dialysis for FI, 3.2% of the days and least on GR (0.2%), CV (0.4%). $P < 0.0001$. Of the problems 85% were pain and redness. To the contrary there were more problems during dialysis with CV, 9.1% vs. FI 2.7%, and GR 0.9%. $P < 0.0001$. The complications and survival data are similar to those reported by others for quotidian hemodialysis and no different from reports on conventional 3 times per week dialyses. Conclusion: Daily hemodialysis does not adversely affect the different types of blood access. The survival and intervention need of accesses is best for fistulae, worst for CV, but GR, when functioning, have fewer problems between and during dialyses.

*C. Kjellstrand*, Aksys, Ltd., Lincolnshire, IL, USA, Z. Twardowski, U. Missouri, Columbia MO, USA, J. Bower, U. Mississippi, Jackson MS, USA and CR Blagg NWKC, Seattle WA, USA.

*Acute Renal Failure*

## On-line Haemodiafiltration in the Management of Acute Renal Failure

Purpose – Patients with acute renal failure (ARF) offer particular challenges in terms of cardiovascular stability during renal replacement therapy. Targets for small solute clearance are unclear, removal of inflammatory mediators is desirable, and biocompatible membranes are essential. This study examined the impact of using on-line haemodiafiltration (HDF), which combines convective and diffusive transport, with replacement fluid being produced "on-line" from reverse-osmosed water.

Methods – Clinical outcomes were examined in all patients presenting with ARF. Initially, management of ARF included daily haemodialysis (4 hours with biocompatible membrane). Subsequently, all patients were managed with on-line HDF using the Gambro AK200 Ultra™, daily for 4 hours. In the initial stages of patient management, CVVH was used in the ICU setting throughout the study period.

| | *Pre 1* | *Pre 2* | *Post 1* | *Post 2* |
|---|---|---|---|---|
| Alive (total) | 4 | 9 | 18 | 29* |
| Dead | 10 | 5 | 9 | 11* |
| Alive on chronic HD | 5 | 8 | 11 | 3* |

Results – A comparison was made between the years prior to (Pre-1 and 2) and following (Post-1 and 2) the change to on-line HDF. (* $p < 0.001$ vs Pre 1/Pre 2).

Conclusions – On-line HDF is a modality that combines cardiovascular stability and significant middle molecule clearance. Using on-line HDF in the management of ARF, there were significant improvements in survival and recovery of renal function.

*Rutherford PA*, Held I. University of Wales College of Medicine, Wrexham, UK

## Experience of a Single Romanian Center on CRRT

Daily or intermittent hemodialysis in ARF is, in general, efficient, but the procedure has various complications due to associated comorbidities and unphysiological ways of renal substitution. The aim of the study was to establish the efficiency (hydro-electrolytic equilibrium, acido-basic equilibrium, fluid balance, evolution of renal function, patient survival) and complications (hypotension, hemorrhagic, vascular access, etc.) during CRRT. We performed CRRT in 24 pts with ARF on native kidney ($n = 20$) or renal transplant ($n = 4$). In 19 cases ($M = 11$, $F = 8$, mean age $= 43.2 \pm 15.7$ y, $BW = 49 \pm 7.5$ kg, mean $BP = 107 \pm 16.6$ mmHg) we made CVVHF and in 11 cases ($M = 6$, $F = 5$, mean age $= 39 \pm 9.9$ y, $BW = 55.5 \pm 5.6$ kg, mean $BP = 104 \pm 18.8$ mmHg) CVVHDF. 16pts (66.6%) have been associated severe, one or more comorbidities: MSOF in 2 pt, sepsis in 3pt, coma in 2 pts, anasarca in 6 pts (1pt hepatic cirrhosis, 1pt severe cardiac failure and 4pts nephrotic syndrome), CID in 1pt, acute pancreatitis in 3 pt, liver failure and hepato-renal syndrome in 1 pt. Mean period of CVVHF was $21.6 \pm 11.3$ h with a mean blood flow rate of $116.9 \pm 16.4$ ml/min and an ultrafiltration rate of $6.42 \pm 4.6$ ml/min. Creatininemia level decreased from 12.6 to 8.3 mg% and urea level decreased from 237 to 166 mg%. In CVVHDF mean period of procedure was $24.0 \pm 8.5$ h, mean blood flow $134 \pm 15.2$ ml/min and mean ultrafiltration rate $5.6 \pm 2.1$ ml/min. Decreased of creatininemia level was from 11.6 to 6.36 mg% and for urea level from 236 to 137 mg%. Vascular approach was by jugular vein in 15 pts, femoral vein in 6 pts, subclavia vein in 1 pt and native fistula in 2 pts. Anticoagulation was performed with UHF in 14 pts and LMWH in 9 pts. In 1 pt anticoagulation was performed by repeated washback with saline solution.

Renal function was recovery completely in 8 pts (33.3%), partially in 4 pts (17.2%) and 10 pts (41.7%) goes to chronic HD. Survival rate was 100% in CVVHF and 82% in CVVVHDF (2 pts died). Complications of procedures appear in 5/24 pts (20.8%) and were represented by cardiac events (hypotension in 2 pts, arrhythmia in 1 pt), bleeding disorders (hemorrhages in 2 pts, clotting in dialyser or lines in 4 pts) and diselectrolithemias (hypophosphatemia in 2 pts). In 1 pt has been necessary to change the femoral catheter to subclavia site due to thrombosis. In conclusion,

continuous renal replacement therapy is efficient and well tolerated with a low frequency of complications.

*M. Voiculescu*, C. Ionescu, G. Ismail, M. Rosu, A Sigheti, Dept. of Internal Medicine-Nephrology, Fundeni Institute, Bucharest, Romania

## Comparison of Dual Dialyzers in Parallel and Series to Improve Urea Clearance in Large Hemodialysis Patients

Dialysis adequacy targets are frequently difficult to achieve in large hemodialysis patients. Dual dialyzers can be used to improve clearance. It is unknown whether series or parallel configurations are superior. Objective: to improve urea clearance in large patients using parallel and series dual dialyzers. Patients and Methods: Eighteen large hemodialysis patients (mean 92.4 kg) were enrolled in a randomized, crossover trial to directly compare dual dialyzers in parallel and series configurations. Treatments times, blood flow rates, and dialysate flow rates were kept constant. Results: Compared to single dialyzers, parallel dual dialyzers increased the spKt/V from 1.25 +/− 0.22 to 1.43 +/− 0.29 ($p < 0.003$). Series dual dialyzers improved the spKt/V to 1.46 +/− 0.26 ($p < 0.0003$ compared to single dialyzer). The Kt/V and URR of dual dialyzers in parallel were not significantly different from dual dialyzers in series. Half of the subjects failed to meet the NKF-K/DOQI recommended adequacy target of spKt/V urea >/= 1.2 using a single dialyzer. With the use of dual dialyzers 83% of subjects achieved this adequacy target. Serum levels of 'middle molecule,' beta-2 microgobulin, were reduced 34% after two months of dual dialyzer therapy. Cost analysis estimates annual net savings of $1260 with dual dialyzer therapy, primarily from projected savings in inpatient expenses. Conclusions: In large hemodialysis patients, our study demonstrates that dual dialyzers in parallel and series are equally effective in improving urea clearance without prolonging dialysis treatment times.

Fritz B., *Doss S.*, McCann L., Wrone E., Satellite Healthcare, Inc., Redwood City, CA, USA.

## Detoxifying Capacity and Kinetics of the Molecular Adsorbent Recycling System: Contribution of the Different Filters Inbuilt

Extracorporeal liver support therapies have been used for several decades as a bridging therapy prior to liver transplantation or as an addendum to standard medical therapy. The molecular adsorbent recycling system (MARS) represents a cell-free, extracorporeal, liver assistance method for the removal of both albumin-bound and water-soluble endogenous toxins. The aim of the present study was to evaluate the short-and long-term removal capacity and selectivity of the different inbuilt dialysers and adsorption columns (uncoated charcoal, anion exchanger resin). Levels of endogenous toxins and parameters of hepatic synthesis and necrosis were therefore monitored before, during, and after the MARS treatment phase in 10 patients. Moreover, blood and dialysate clearances of urea nitrogen, creatinine, bilirubin and bile acids were determined during a single treatment. The significant increasing time course of total bilirubin blood levels before the start of the treatment could be stopped and reversed in a significant decreasing time course (Linear Mixed Models, $P < 0.05$). The removal rate of urea nitrogen, bilirubin, and bile acids during a single treatment amounted to $55.5 \pm 4.0\%$, $28.3 \pm 3.9\%$, and $55.4 \pm 4.0\%$ (mean $\pm$ SEM), respectively. Bile acids and bilirubin were mainly removed by the activated charcoal and anion exchanger column, respectively. The efficacy of removal of albumin-bound toxins sharply declined early after initiation of the treatment to become negligible after 6 h. In conclusion, both albumin-bound and water-soluble toxins are adequately removed by the MARS. Our data suggest that the rate and efficacy of removal of albumin-bound toxins is related to both the strength of the albumin binding and the saturation of the adsorption columns.

*Evenepoel P.*, Maes B., Wilmer A., Nevens F.,Fevery J., Kuypers D., Bammens B., Vanrenterghem Y., University Hospital Gasthuisberg, Leuven, Belgium

## Short Daily Dialysis (SDHD) Efficacy: Pilot Multicentric Study with Nine Patients from Madrid

Interest in quotidian (daily) hemodialysis (HD) seems to be growing. Clinical data consistently showed improved quality of life, better control of blood pressure, less need for medications including erythropoietin (EPO) and better nutrition. We evaluate the SDHD efficacy in 9 patients in conventional HD (3 weekly sesions/4 hours), mean age 57,78 years range (33–75), 6 males and 3 females who needed increased dialysis efficiency by different medical indications: 5 cases with hypertensive miocardiopathy and severe LVH, 2 of them with EFLV 26% and 27%. 2 cases with ischemic cardiopathy symptoms, one of them with anger and restless dysnea with a non resvascularizable coronary lesion, and other with cardiac insufficiency episodes requiring hospitalization once a month. 1 patient with big body surface area and elevated phosphorus levels although without control, with conventional three times/week HD. 1 patient indication was made by 12 years on HD with multiple vascular accesses failed needing a Tessio cathéter being into infradialysis regimen for his malnutrition status.The schedule in all of them was 6 days per week sessions between 2.15 hrs till 3 hours depending of body surface area to obtain a weekly kt/v nearest to 4. HD session were realized in the Hospital (4 pts) or in satellite unit (5 pts) due to the characteristics of the patients. The time remaining in this schedule was between 5 months to 2 years and 9 months. All the patients showed clinical improvement, subjective and objective, since the first weeks of starting SDHD. Sleep symptoms were the first to improve. All patients showing good coping with this HD

alternative. Blood pressure levels were controlled without need for antihypertensive drugs, although the dry weight increased significantly in all cases. Albumin serum levels increased as nutrition parameter, controlling also the osteodystrophy and phosphorus. In a patient the EFLV was normalized from 6 months (26%–50%) improving in other. Two patients could be included in Tx waiting list. Again, anemia improved and decreasing EPO was required. No vascular access (autologous AVF) malfunction was detected in relation to daily procedure. Conclusion: Our pilot experience shows a clinical and biochemical improvement in the patients and quality of life as well. Prospective studies to demonstrate the financial benefits of these modalities are needed.

*G. Barril*, E. Besada[1], P. Caro[2], F. Dapena[2], P. Sanz, S. Cigarran[3], R. Selgas D. Nephrology H. U. Princesa; [1]Asdho FMC Torrejón, [2]C.Ruber, [3]El Pilar FMC, Madrid, Spain.

## The Relative Contribution of Residual Renal Function and Adequacy of Dialysis to Survival in Hemodialysis Patients

A high delivered $Kt/V_{urea}$ is advocated in the DOQI guidelines on hemodialyis (HD) adequacy. However, the contribution of residual renal function to overall urea clearance is neglected. We investigated the relative contribution of residual renal $Kt/V_{urea}$ and delivered $Kt/V_{urea}$ to patient survival. Furthermore, we investigated whether other characteristics of HD treatment may be independently associated with survival.

The NECOSAD study is a prospective multi-center study and includes ESRD patients older than 18 years who start dialysis as their first renal replacement therapy. We analyzed the longitudinal data on residual renal function and dialysis adequacy of those patients who were treated with HD 3 months after the start ($n = 704$).

The mean age was 62 years. The mean renal $Kt/V_{urea}$ at 3 months was 0.7/week (SD: 0.6) and the mean dialysis $Kt/V_{urea}$ at 3 months was 2.7/week (SD: 0.8). The 2-year survival was 73.5%. Both a higher weekly renal $Kt/V_{urea}$ and a higher delivered $Kt/V_{urea}$ were significantly and independently associated with a better survival (P values $< 0.002$). However, the effect of renal $Kt/V_{urea}$ appeared to be significantly more pronounced ($RR = 0.39$ versus 0.72, $P = 0.0014$). The beneficial effect of delivered $Kt/V_{urea}$ on survival became less and disappeared at increasing levels of renal $Kt/V_{urea}$. When the difference between the interdialytic weight gain and the ultrafiltration exceeded $-280$ mL/week (i.e., an excess of ultrafiltration) an increase in mortality was found, independently of renal and delivered $Kt/V_{urea}$ ($RR = 1.94$, $P < 0.05$).

These data indicate that residual renal function is an important predictor of mortality in hemodialysis patients and that the delivered $Kt/V_{urea}$ needs to be appropriately tuned to the renal $Kt/V_{urea}$. Furthermore, close monitoring of fluid balance is also an important measure of dialysis adequacy.

*Termorshuizen Fabian*[1], Korevaar Johanna C.[1], Dekker Friedo W.[2], van Manen Jeannette G.[1], Boeschoten Elisabeth W.[3,4], Krediet Raymond T.[4] for the NECOSAD Study Group. [1]Department of Clinical Epidemiology and Biostatistics, Academic Medical Center, Amsterdam, The Netherlands. [2]Department of Clinical Epidemiology, Leiden University Medical Center, Leiden. [3]Dianet Dialysis Centers, Utrecht and Amsterdam. [4]Department of Nephrology, Academic Medical Center, Amsterdam, The Netherlands.

## Optimal Control of Phosphatemia by Short Daily Hemodialysis

Hyperphosphatemia is a major risk factor in maintenance of hemodialysis patients, not only in the pathogenesis of secondary hyperparathyroidism but also in the progressive calcic vascular disease. Phosphorus is present in all nutrients rich in proteins and we can't remove completely phosphorus intake by diet restriction or phosphate binders. Better nutritional status with higher protein intake appears with short daily hemodialysis (SDHD). Does SDHD allow a better phosphorus elimination than SHD?

Ten patients mean age $52.3 \pm 6.4$ yrs treated on standard hemodialysis (SHD) from $11.2 \pm 4.3$ yrs 4 to 5 h × 3/week were switched to SDHD 2 to 2.5 h × 6/week. We have compared in the same patient phosphatemia (P), weekly phosphates removal (WPR), daily phosphates intake (DPI), and phosphates binders in SHD and in SDHD at the third month (SDHD1) and at long term (SDHD2).

Results were expressed as mean ± SD and statistical analysis between SHD and SDHD were studied using Students paired t-test.

| | *SHD* | *SDHD1* | *SDHD2* |
|---|---|---|---|
| P (mmol/l) | $2.3 \pm 0.7$ | $1.9 \pm 0.5$** | $1.8 \pm 0.4$** |
| WPR (mmol) | $99.8 \pm 20.8$ | $113.5 \pm 25.8$* | $128.2 \pm 45.8$* |
| DPI (mg) | $968 \pm 192$ | $1149 \pm 223$** | $1535 \pm 701$* |
| P binders | +++ | ++ | ++ |
| | * $p < 0.05$ | ** $p < 0.001$ | |

P was significantly lower in SDHD despite a reduction in phosphates binders and high phosphates intake with better nutritional status as seen usually with SDHD. There were no significant differences between either P and DPI in the two periods on SDHD. We have confirmed these results by kinetics studies showing that 60% of phosphate elimination take place mainly during the first 2 h of dialysis sessions; so the overall WPR is higher with SDHD.

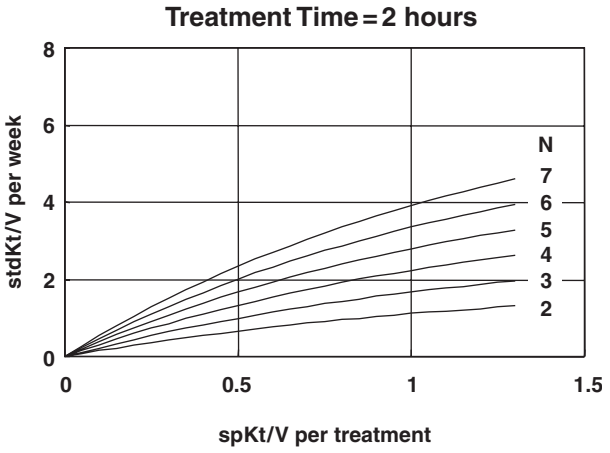
We conclude that increased sessions frequency increases phosphates elimination and decreases the risk of hyperphosphatemia.

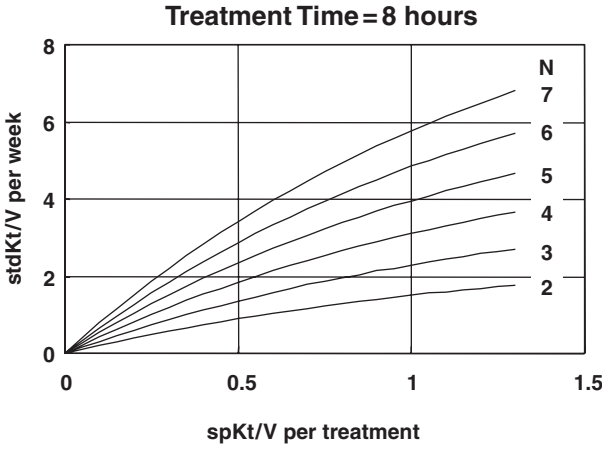
*Galland R.*, Traeger J., Delawari E., Arkouche W. (AURAL) Lyon, France.

## Calculation of Standard Kt/V (stdKt/V) with Corrections for Postdialysis Urea Rebound

Recent work has shown that postdialysis urea rebound and equilibrated Kt/V (eKt/V) for short daily therapies, either hemodialysis (HD; Leypoldt et al, 2002 ASN meeting) or hemofiltration (HF; Jaber et al, this meeting), cannot be predicted by the Daugirdas-Schneditz rate equation. We derived a modified rate equation that accurately predicts eKt/V from single-pool Kt/V (spKt/V) and used it to derive nomograms for calculating stdKt/V from spKt/V for therapies containing an arbitrary number (N) of either short (2 hr) or long (8 hr) treatments per week. The modified rate equation was derived using multiple linear regression from measured spKt/V and eKt/V values during conventional (4 hr) HD ($n = 21$), short (2 hr) HD ($n = 21$) and short (2–3 hr) HF ($n = 33$). Values of stdKt/V were calculated using a fixed-volume kinetic model: stdKt/V = 168*(1-exp- [-eKt/V])/t/((1-exp [-eKt/V])/(eKt/V)+ 168/N/t-1), where t = treatment time in hrs.

Measured values of spKt/V ranged from 0.38–1.89 and treatment rate (K/V) from 0.10–0.63/hr. The derived modified rate equation was: eKt/V = 0.927*spKt/V− 0.255*K/V. Prediction of eKt/V from this equation was high ($r^2 = 0.986$, $p < 0.0001$), and calculated relationships between stdKt/V per week and spKt/V per treatment are as shown in the figures below.




We suggest that stdKt/V can be predicted from spKt/V values using a modified rate equation and a fixed-volume kinetic model.

*Leypoldt J.K.*[1], Jaber B.L.[2], Zimmerman D.L.[3], [1]Univ. of Utah & SLCVAHCS, Salt Lake City, UT, USA, [2]New Engl. Med. Cntr., Boston, MA, USA, [3]Univ. of Ottawa, Ottawa, Canada.

## Adequacy of Daily Hemofiltration (HF): Clinical Evaluation of Standard Kt/V

Standard Kt/V (stdKt/V) has been proposed as a dose measure for daily therapies (adequate therapy defined as stdKt/V ≥ 2.0), but this parameter is difficult to evaluate without determining equilibrated Kt/V (eKt/V). We determined eKt/V in 34 urea kinetic modeling (UKM) sessions from 13 patients undergoing daily HF (6 times/wk) in 2 different centers with a single-pool Kt/V (spKt/V) goal of 0.40. The patient characteristics were as follows: age 55 ± 19 (SD) years; 9 males; 3 diabetics; and dry weight 71.1 ± 14.4 kg. Urea concentration was measured pre-HF, and 0 and 60 min post-HF. spKt/V and eKt/V were calculated using the 0- and 60-min post-HF urea concentrations, respectively, and eKt/V was corrected for urea generation post-HF. eKt/V was also predicted from spKt/V using the Daugirdas-Schneditz (DS) rate equation. stdKt/V was calculated using the Gotch fixed-volume kinetic model equation. Results:

| *Treatment and UKM parameters* | *Mean ± SD* |
|---|---|
| Treatment time, hour | 2.32 ± 0.68 |
| Blood flow rate, ml/min | 485 ± 23 |
| Replacement fluid volume, L | 12.7 ± 2.1 |
| Net volume removed, L | 1.1 ± 0.8 |
| Measured spKt/V | 0.441 ± 0.041 |
| Measured eKt/V | 0.388 ± 0.063* |
| Predicted eKt/V | 0.350 ± 0.047 |
| stdKt/V, per week | 1.95 ± 0.26 |

Measured eKt/V was greater than that predicted (*$p < 0.001$).

We conclude that 1) the DS rate equation cannot be used to accurately predict eKt/V during daily HF and 2) daily HF with an exchange (replacement plus removed) volume of 20% of body weight (13.8 L/71.1 kg = 19.4%) delivers a weekly stdKt/V of ~2.0.

*Jaber B.L.*[1], Zimmerman D.L.[2], Leypoldt J.K.[3]. [1]New Engl. Med. Cntr., Boston, MA, USA, [2]Univ. of Ottawa, Ottawa, Canada, [3]Univ. of Utah & SLCVAHCS, Salt Lake City, UT, USA.

## Reduced-Dimensional Radial Basis Neural Network for Monitoring Haemodialysis

Efficiency of haemodialysis is determined by calculating adequacy. Current practice utilizes invasive procedures,

such as the periodic measurement of blood urea nitrogen levels for monitoring haemodialysis. Medical informatics has not been used to study haemodialysis. Here an algorithmic approach is presented to calculate adequacy using generalised radial basis function neural networks (GRBFN). Previous work by the authors has shown the performance of a GRBFN when compared to the DDQ method.

TABLE I Comparison between UN removal calculated by DDQ and that predicted by GRBFN.

| Weight | Time INPUTS | BUN | Calculated UN Removal - DDQ | Predicted UN Removal - GRBFN | % PE (GRBFN) |
|---|---|---|---|---|---|
| 67.47±17.79 | 30 | 68.07±17.73 | 37.26±10.87 | 34.48±0.48 | 1.70 |
| 66.93±17.18 | 60 | 8.33±14.35 | 36.83±11.69 | 31.48±0.31 | 7.41 |
| 66.33±17.19 | 90 | 51.93±13.77 | 29.59±8.11 | 28.44±0.23 | 0.35 |
| 65.87±16.98 | 120 | 44.53±11.61 | 26.98±7.95 | 25.56±0.25 | 1.23 |
| 65.53±17.07 | 150 | 39.20±11.18 | 22.67±7.11 | 21.83±0.19 | 2.46 |
| 65.20±17.10 | 180 | 34.47±10.66 | 18.99±5.23 | 19.66±0.14 | 4.37 |
| 64.73±16.79 | 210 | 30.53±9.46 | 15.91±5.68 | 17.04±0.15 | 8.80 |
| 64.67±16.78 | 240 | 27.67±8.97 | 12.31±4.5 | 13.39±0.06 | 14.16 |

Next, adequacy was measured using those quantities that are non-invasive.

TABLE II Comparison between UN removal calculated by DDQ and that predicted by the 2 GRBFN architectures (NEW GRBFN inputs – Time, Weight; OLD GRBFN inputs – Bun, Time, Weight).

| *Time* | *Calculated UNRemoval-DDQ* | *Predicted UN Removal (OLD GRBFN)* | *Predicted UN Removal (NEW GRBFN )* | *% PE (OLD GRBFN)* | *% PE (NEW GRBFN)* |
|---|---|---|---|---|---|
| 0 | $35.08 \pm 3.33$ | $34.48 \pm 0.48$ | $34.72 \pm 0.07$ | 1.70 | 1.02 |
| 60 | $34.00 \pm 3.04$ | $31.48 \pm 0.31$ | $31.60 \pm 0.03$ | 7.41 | 7.06 |
| 90 | $28.54 \pm 2.72$ | $28.44 \pm 0.23$ | $28.48 \pm 0.07$ | 0.34 | 0.23 |
| 120 | $25.88 \pm 3.72$ | $25.56 \pm 0.25$ | $25.64 \pm 0.01$ | 1.23 | 0.94 |
| 150 | $22.38 \pm 1.14$ | $21.83 \pm 0.19$ | $21.89 \pm 0.03$ | 2.46 | 2.20 |
| 180 | $20.56 \pm 4.09$ | $19.66 \pm 0.14$ | $19.70 \pm 0.03$ | 4.37 | 4.21 |
| 210 | $18.68 \pm 1.88$ | $17.04 \pm 0.15$ | $17.07 \pm 0.08$ | 8.80 | 8.63 |
| 240 | $15.60 \pm 3.98$ | $13.40 \pm 0.06$ | $13.40 \pm 0.02$ | 14.16 | 14.16 |

This study presents a better and more convenient algorithmic procedure that provides the physician with a better guide to the prescription of haemodialysis.

*Ray, Monika* and Qidwai, Uvais. Tulane University, School of Engineering, New Orleans, LA, USA.

## Stress Is the Strongest Predictor of Death in Hemodialysis and Can Be Measured

The overall results of hemodialysis are not good with a 90%, 5-year death rate in most Western countries. Several self-evident variables: age, diagnosis, and comorbidity predict death but there are inexplicable individual variations. The usual measure of hemodialysis, "Kt/V" has been useless in predicting mortality. We speculated that it would be most important to study individual stress reactions to dialysis. We measured two important peptides measuring stress: ANP and NPY and created a stress index $= (\text{ANP} + 3 \times \text{NPY})$. ANP reacts to the stress of fluid overload and NPY reacts to fluid overload, blood pressure and nervous overactivity. The stress index was measured in 33 patients that were followed for up to 12 years. All 12 patients (HSI) with a stress index above the mean of 275 ng/l died compared to 6/21 of patients (LSI) with an index below mean $p < 0.0001$. 50% survival HIS was at 29 months, compared to 116 months for LSI, $p = 0.003$. The following factors were correlated to the stress index:

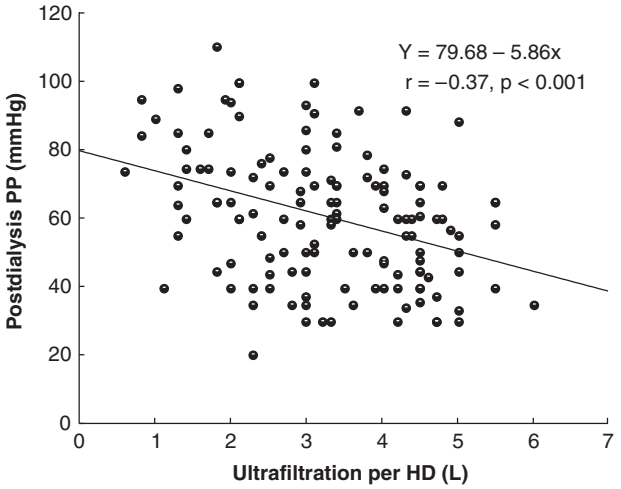
| | *R* | *p* |
|---|---|---|
| Age | 0.4 | 0.026 |
| MAP | 0.5 | 0.005 |
| Weight gain | 0.4 | 0.036 |
| Heart volume | 0.4 | 0.010 |
| Heart failure | 0.6 | $< 0.0001$ |
| Ischemic HD | 0.6 | $< 0.0001$ |

Not correlated were albumin, Kt/V, BMI, LVH, Hgb, time on dialysis. In stepwise Cox proportional hazard analysis with all of the above factors, significant in predicting survival as co-variates were the stress index, albumin and heart volume. Conclusions: Stress index captures the combined influence of age, fluid overload, MAP, HV, HF, IHD and is the most significant of all variables associated with death. In hemodialysis patients with a high stress index one should modify dialysis; daily, longer, and slower hemodialysis should be strongly considered. Conventional, fast three times per week is contraindicated in such patients.

Odar-Cederlof I, Karolinska Institute Stockholm Sweden and *Kjellstrand C.* Aksys, Ltd., Lincolnshire, IL, USA.

## Pulse Pressure Determinants in Chronic Hemodialysis Patients

**Introduction**: Hypertension contributes to the cardiovascular morbidity in patients undergoing chronic hemodialysis therapy (PCHD). Pulse pressure (PP) was recognized as a correlate of mortality in PCHD. In order to demonstrate determinants of predialysis and postdialysis PP values in a group of PCHD, we conducted this study. **Subjects and methods**: Study subjects were 23 PCHD. Study time was 15 months. One hundred thirty six single hemodialysis (HD) treatments were processed. PP was computed as systolic-diastolic blood pressure (mmHg). Statistical methods used were Student's t test for independent data, multivariate analysis of variance, Pearson's correlation, and forward stepwise multiple regression analysis. **Results**: Postdialysis and predialysis PPs differed significantly ($65.51 \pm 19.00$ vs. $60.55 \pm 19.35$, $p = 0.002$). We did not find gender differences in PP before and after HD. PP before HD was in negative correlation with phosphorus concentration ($r = -0.244$, $p = 0.002$), parathyroid




hormone (PTH) ($r = -0.177$, $p = 0.020$), hemoglobin ($r = -0.301$, $p < 0.001$), single HD duration ($r = -0.162$, $p = 0.030$), ultrafiltration rate per HD ($r = -0.290$, $p = 0.001$), years on the chronic hemodialysis treatment ($r = -0.261$, $p = 0.001$) and ultrafiltration volume/dry body mass ratio (UF/W) ($r = -0.222$, $p = 0.005$) and in positive concentration with weekly erythropoietin ($r = 0.391$, $p < 001$) and age ($r = 0.285$, $p < 0.001$). PP after HD was in significant negative correlation with phosphorus concentration ($r = -0.205$, $p = 0.009$), PTH ($r = -0.187$, $p = 0.015$), hemoglobin ($r = -0.238$, $p = 0.005$), ultrafiltration per HD ($r = -0.370$, $p < 0.001$), dry body mass index ($r = -0.225$, $p = 0.003$), years of the chronic hemodialysis treatment ($r = 0.330$, $p < 0.001$), UF/W ($r = -0.340$, $p < 0.001$) and in positive concentration with weekly erythropoietin ($r = 0.361$, $p < 0.001$) and age ($r = 0.227$, $p = 0.004$). Multiple regression analyses unveiled the strongest and negative correlations between PP after HD and UF/W ratio ($\beta = -0.41$, $p < 0.001$). The strongest, but positive correlation was found between PP before HD and erythropoietin per week ($\beta = 0.51$, $p < 0.001$). **Conclusion**: Determinants of the pre/post PP values are similar. Ultrafiltration is a strong predictor of postdialysis PP value.

*Kovacic V*, Sain M, Dzanko D, Vukman V. Hemodialysis department of Medical Center Trogir, Croatia.

## Drug-Related Problems in Hemodialysis Patients

Polypharmacy is common in hemodialysis patients. The objective of this study is to identify drug-related problems (DRPs) in hemodialysis patients, intervene, and resolve them. All patients undergoing dialysis at a hemodialysis center were enrolled into the study. Patients who had been hospitalized during the study period were excluded. DRPs were identified after thorough review of the patients' medication and clinical records. DRPs were classified into 8 categories and any DRP that did not fit into the 8 categories was classified under 'Others.' Appropriate recommendations for the resolution of the DRPs were presented to the nephrologist in-charge of the center and action taken. Accepted recommendations were deemed as interventions and assigned a significance rank on a scale of 1 (adverse significance) to 6 (extreme significance). Where recommendations were accepted, monitoring was carried out 2 weeks later to assess the clinical outcome of the intervention. A total of 35 patients were studied. 31 patients completed the study, 4 were lost to follow-up. In a 3-month period, 83 DRPs were identified and 73 interventions (88%) made. A mean of $2.7 \pm 1.1$ DRPs were detected per patient. Drug underdose constituted the most common DRP accounting for 35% of all DRPs. 62% of the accepted recommendations were classified as significant and given a rank of 4/6. On follow-up, 54% of the interventions showed improved clinical outcomes. DRPs are prevalent in hemodialysis patients. The introduction of clinical pharmacy services can potentially contribute to many aspects of healthcare in hemodialysis patients through the detection and resolution of DRPs. Where clinical pharmacy services are not available, clinicians should be vigilant regarding polypharamcy and the occurrence of DRPs.

Chua P.C.P., Low C.L., *Lye W.C.* Dept of Pharmacy, National University Singapore and Centre for Kidney Diseases, Singapore.

## Patient Education and Its Effects on Calcium-Phosphate Balance in Hemodialysis Patients

Calcium-phosphate imbalance is common in hemodialysis patients and is an important cause of increased morbidity and mortality. The objective of this study is to determine the effectiveness of patient education in improving calcium-phosphate balance. This is a cross-sectional cohort study with a control group. Hemodialysis patients at 2 centers with serum phosphate levels $\geq 4.5$ mg/dL and a Ca $\times$ P product $> 55\ mg^2/dl^2$ were enrolled into the study. The patients were interviewed to determine their knowledge of phosphate binders, compliance and dietary restrictions. Formal counseling was provided to ensure that the patients were aware of the importance of taking their phosphate binders regularly and the adverse consequences of hyperphosphatemia. At the end of 3 months, the patients' serum calcium and phosphate levels and CaxP product were measured. In the control arm, no formal counseling was done. 31 patients were enrolled in the study arm and 30 patients were controls. At the start of the study, 39% of patients in the study group were incompliant with their phosphate binders. After counseling, there was a significant decrease in the serum phosphate level ($8.6 \pm 0.4$ vs $7.4 \pm 0.6$ mg/dl, $p < 0.05$) and Ca $\times$ P product ($83.6 \pm 4.9$ vs $68.9 \pm 5.6\ mg^2/dl^2$, $p < 0.01$) of the patients at one month. At 3 months, the mean serum phosphate level and Ca $\times$ P product had returned to baseline levels. No significant changes were noted in the control arm. This study suggests that patient education on the use phosphate binders had a positive impact on hyperphosphatemia.

However, the effect was lost after one month and continuing patient education may be needed to achieve a long-term result.

Fung K.Y., Low C.L, *Lye W.C.* Dept of Pharmacy, National University Singapore and Centre for Kidney Diseases, Singapore

## The Effect of Long Nocturnal Dialysis on Ca/Ph and Bone Status

Objective: Long nocturnal dialysis (LND) has been advocated as a way to improve dialysis outcomes by improving adequacy. The effect of long dialysis on calcium phosphorus balance and bone mineralism has not been studied. On one hand, a better removal of phosphorus would potentially lead to better control of Ca/Ph balance, but at the other hand, a negative calcium balance might be present during the long dialysis. This study wanted to evaluate the evolution of Ca/Ph, PTH and bone density in a LND program.

Methods: Retrospective analysis of prospectively collected data on 12 patients in a LND program. Patients-were dialyzed 3*/week during 8 hours, at a Qb of 175–200 and a Qd of 500, with a dialysate calcium concentraion of 1.5 mmol/l. Serum levels of calcium, phosphorus and iPTH were determined predialysis just before patients started the LND program, and after one year. Dual photon absorption bone densitometry was performed, and measurements expressed as T-values to correct for the natural evolution in the general population.

Results: Serum calcium and phosphorus remained stable during LND ($4.59 \pm 0.47$ to $4.73 \pm 0.72$ mEq/l, $p = 0.13$ and $4.99 \pm 2.05$ to $5.35 \pm 1.37$ mg/dl, $p = 0.64$, respectively). There was also no difference in iPTh levels ($318 \pm 312$ to $219 \pm 135$ pg/ml, $p = 0.37$) or in T-scores of BMD ($-2.35 \pm 0.78$ to $-1.39 \pm 1.41$, $p = 0.42$).

Discussion: LND has been advocated as a method to improve dialysis adequacy. The impact on Ca/Ph balance and bone mineralism has however not been studied. In our patient group, there was no evidence for enhanced bone loss during the LND program. Neither was there a tendency for deterioration of the secundary hyperparathyroidism. There was an acceptable control of the phosphorlevels. In conclusion, LND using a 1.5 mmol/l Calcium dialysate does not negatively impact on Ca/Ph balance or on bone density.

Veys N., *Van Biesen W.*, Vanholder R., Lameire N. Dept. of Nephrology, University Hospital, Ghent, Belgium.

## Effect of Long Nocturnal Dialysis on Nutritional Status and Blood Pressure Control

**Objective**: Nutritional status is an important predictor of outcome in dialysis patients. Long nocturnal dialysis (LND) improves clearances, and potentially can have a beneficial impact on nutritional status and on blood pressure control.

**Methods**: Retrospective analysis of a prospectively collected database of 12 patients in a LND program. Patients were dialysed 3*/week during 8 hours, at a Qb of 175–200 ml/min and a Qd of 500 ml/min. Pre-dialysis serum albumin (nephelometric), ideal body weight, systolic blood pressure and residual GFR were measured just before start of LND, and after 1 year.

**Results**: Mean Kt/v for urea over the 1 year period was $1.9 \pm 0.29$/session. Serum albumin increased from $3.83 \pm 0.18$ to $4.12 \pm 0.28$ mg/dl (paired T-test: $p = 0.007$). Ideal body weight increased nonsignificantly from $75.08 \pm 15.35$ to $78.07 \pm 13.49$ kg (paired T-test, $p = 0.39$). Systolic blood pressure decreased from $146.3 \pm 21.7$ to $132.8 \pm 17.3$mmHg (paired T-test, $p = 0.06$)

**Discussion**: Malnutrition is an important predictor of outcome in dialysis patients. Several studies have pointed that an intensification of dialysis adequacy can lead to an enhanced nutritional status. The use of daily dialysis or of nocturnal dialysis can substantially improve delivered Kt/V, as is shown in our patient group. There was a concommitant rise in pre-dialysis serum albumin concentration in all patients. There was also tendency for an increase in total body weight, although this did not reach statistical significance, and was also not present in all patients. This might just be a false impression as the improvement of the pre-dialysis blood pressure might indicate that excess fluid was gradually removed, with an increase in lean body mass and a resulting stable total body weight. In conclusion, LND is well-tolerated, and results in an improvement of serum albumin and pre-dialysis systolic blood pressure.

*Van Biesen W.*, Veys N., Vanholder R., Lameire N. Dept. of Nephrology, University Hospital, Ghent, Belgium.

## Citrate Dialysis – Adverse Effects

Trisodium citrate 33% as anticoagulant is routinely used in several indications for acute dialysis patients, with very good clinical tolerance and results. But in chronic dialysis patients two problems arose after some weeks : 1/ In all of them hypernatremia and alcalosis developed : the pre dialysis sodium and bicarbonate level raised progressively. This could be tempered by lowering the sodium and dialysate bicarbonate concentration respectively from 140 mEq/l to 132 mEq/l and from 37 mEq/l to 25 mEq/l. 2/ The second problem was a progressive rise in serum Aluminum (Al) level in some patients: from a mean 3 $\mu$g/l to 38 $\mu$g/l; after excluding water, concentrate, dialysate, medication, etc. as possible cause, we finally controlled the Al level in the glass bottles, containing the trisodium citrate solution, and we noted very high values:35,300 $\mu$g/l. After replacement of the glass bottles by polyvinyl bags (with a neglectable Al content), the serum Al levels returned to normal. It is known that citrate chelates also the Al present in the glass of the bottles or vials themselves; our warning is not to use glass containers for citrate solutions. A short overview of different glass types is given.

*Hombrouckx Remi O J*; De Vos Jean-Yves AZ Werken Glorieux, Dialysis Unit, Ronse, Belgium

## Regional Citrate Anticoagulation with Duocart-biofiltration (DCB) versus Conventional Bicarbonate Hemodialysis (BHD) with Low Molecular Weight Heparin (LMWH)

**Background**: LMWH ensures circuit permeability in hemodialysis but can lead to systemic bleeding for patients with hemorrhagic risk. Other anticoagulation alternatives are laborious and cumbersome with BHD. Regional citrate anticoagulation can be simplified with DCB, a new hemodialysis method using a dialysate containing only sodium chloride and bicarbonate. The optimal amount of ionic complement (Ca++, Mg++, K+) is automatically perfused into venous line according to the value of ionic dialysance measured every 15 minutes by the Integra dialysis monitor (Hospal, Italy).

**Methods**: Thirty DCB-citrate sessions were performed in 10 patients at increased risk of bleeding. After resolution of bleeding risk, the same number of BHD sessions was performed in patients. The aim of this study is to compare pressure time of the arterio-venous access (PT), index thrombosis circuit (ITC 0:clean to 5:total thrombosis), Kt/V and biochemical data at the end of sessions (mean ± SD).

| | *DCB-citrate (n = 21)* | *BHD-LMWH (n = 21)* | *p* |
|---|---|---|---|
| PT (min) | 4 ± 1.1 | 9 ± 4.6 | < 0,01 |
| ITC | 1.75 ± 0.34 | 2.4 ± 0.6 | < 0,01 |
| Kt/V | 1.21 ± 0.25 | 1.21 ± 0.27 | NS |
| Ca++(mmol/l) | 2.8 ± 0.25 | 2.8 ± 0.2 | NS |
| HCO3- (mmol/l) | 26 ± 2.7 | 29 ± 3 | 0,01 |

No bleeding, and no metabolic or citrate adverse-event were observed during DCB-citrate sessions. No change in perfusion rate of ionic complement was required.

**Conclusion**: Regional citrate anticoagulation during DCB is safe, effective and good alternative of HBPM for patients with hemorrhagic risks.

*Christophe Ridel*[1]*, Lucile Mercadal[1], Bernard Bene[2], Gilbert Deray[1] and Thierry Petitclerc[1]. [1]Dept of Nephrology, Pitié-Salpétrière Hospital, Paris and [2]Hospal R & D, Lyon, France.

## Hemodialysis Patients' Fluid Balance & Predialysis Assessment

In Nova Scotia and Prince Edward Island, Canada, there are 14 hemodialysis satellite clinics staffed by hemodialysis clinic assistants who are trained to perform the hemodialysis treatment and provide appropriate troubleshooting.

A need was identified to provide additional education regarding patients' fluid balance and predialysis assessment. Due to the location of the satellites throughout the two provinces, the education session was provided through telehealth. In advance of the telehealth session, the goals and process were explained to all clinic staff. The telehealth session consisted of a presentation by a nephrologist on fluid balance, dialysis parameters and appropriate intervention for complications during dialysis. Information packets and worksheets were prepared and sent to all satellite clinic staff. The information packets described what the staff should be including in their predialysis assessment of the patient, i.e., vital signs, any changes, signs of fluid overload or dehydration, and reviewing the past six record sheets for trends. The staff had an opportunity to provide feedback using the worksheets and ask questions to clarify information.

The telehealth session proved to be very interactive, successful and an excellent tool for interactive education of satellite clinic staff.

This poster presentation will include highlights from the nephrologist's lecture and information provided in the packets and the worksheets.

*Garrett, K. R.*, Home Dialysis Unit, Queen Elizabeth II Health Sciences Centre, Halifax, Nova Scotia, Canada.

## Hospitalizations in Patients on Chronic Hemodialysis (HD)

We analyzed causes, duration, and outcomes of hospitalization in patients on HD followed in a dialysis unit. We identified a total of 42 patients (40 men, 2 women), 34–93 (66.3 ± 12.8) years of age. The causes of renal failure included diabetic nephropathy in 23 patients (54.8%), hypertensive nephrosclerosis in 7 (16.7%), primary renal disease in 7 (16.7%), obstructive uropathy in 3 (7.1%) and unknown illness in 2 patients (4.7%). Over a 12-month period, these patients had 96 hospitalizations (2.3 per pt). Duration of hospitalization was 29.9 ± 47.4 days per pt annually. Nine subjects (21.4%, age 71.4 ± 12.5 years, diabetes 66.7%) had no hospitalization, while 8 subjects (19.0%, age 61.0 ± 19.0 years, diabetes 75.5%) had ≥ 4 hospitalizations. Hospitalizations were more frequent (2.8 vs. 2.0 annually) and marginally longer (37.9 ± 51.2 vs. 20.2 ± 29.4 days annually per pt, $p = 0.06$)) in patients with than those without diabetes. Among the admissions, 30 (31.3%, 8.9 days annually per pt) were due to vascular access complications (clotting, infections − 2 with endocarditis-, etc), 16 (16.7%, 9.0 days annually per pt) were due to leg gangrene (8 amputations), 13 (13.5%, 1.5 days annually per pt) were due to cardiac causes or stroke, 12 (12.5%, 2.3 days annually per pt) were due to hypervolemia or metabolic derangements hypoglycemia, hyperglycemia, hyperkalemia), 8 (8.3%, 2.6 days annually per pt) were due to elective surgical procedures, 7 (7.3%, 4.1 days annually per pt) were due to respiratory disease, and 10 (10.4%, 1.6 days annually per pt) were due to miscellaneous causes including psychiatric disease (3 admissions), warfarin overdose (2 admissions), liver abscess, urinary tract infection, enteric polyps, metastatic prostate cancer, and terminal care. Four patients died during hospitalization from cardiac causes (2), respiratory failure (1) and uremia after stopping dialysis (1). Hospitalizations are frequent and prolonged in patients on HD, particularly those with diabetic nephropathy. Vascular access complications and

ischemic events in the legs, rather than cardiac causes, are the major causes of hospitalization in HD patients.

Saad E, Servilla KS, *Tzamaloukas AH*. New Mexico VA Health Care System and University of New Mexico, Albuquerque, NM, USA.

## Severe Hyperparathyroidism Despite Paricalcitol (Zemplar) Therapy: One Year Follow-up

Paricalcitol, a new Vit. D analogue is thought to be more potent than Calcitriol and has also been reported to cause less hypercalcemia. We report one-year follow-up on patients (N = 74) from one inner city dialysis unit. Patients were stratified in groups A, B, C, D depending on intact Paratharmone (iPTH) levels i.e., < 100, 100–300, 300–600, > 600 respectively. Serum Ca, $PO_4$, alkaline phosphatase (ALK), albumin (ALB), hemoglobin (Hb) was measured monthly and serum iPTH was checked quarterly. The results are as follows:

| *Group* | # | *PTH pg/dl* | *Ca mg/dl* | *PO4 mg/dl* | *ZPR mcg/hd* | *Hb g/dl* | *EPO U/kg/hd* |
|---|---|---|---|---|---|---|---|
| A | 6 | 56.83* | 9.74 | 5.32 | 0 | 11.72 | 255.8† |
| B | 22 | 197.01** | 9.04 | 5.53 | 2.48¶ | 12.12 | 137.55 |
| C | 29 | 422.89** | 9.4 | 5.73 | 4.54¶¶ | 11.86 | 128.87 |
| D | 17 | 1253.4** | 9.88 | 7.21 | 12.51¶¶ | 12.1 | 74.35†† |

**PTH**: $p < 0.05$ = *vs**, **ZPR** (zemplar): $p < 0.05$¶ vs¶¶, mcg: microgram

**EPO** (erythropoietin): $p < 0.05$ = † vs††,

Mean age, weight, URR, ALB., ALK. and iron indices were not statistically different in all groups. Mean duration of hemodialysis (HD) was 34, 30, 57 & 65 months in groups A, B, C, D respectively. None of these patients had symptomatic bone disease. Seven patients were changed to low Ca (1.0 meq/L) bath secondary to hypercalcemia (Ca > 11.5) & severe hyperparathyroidism (HPT).

This data suggest that severe HPT is frequent despite aggressive Paricalcitol therapy in the inner city HD population. More effective noncalcium phosphate binders and/or calcimimetic agents may be needed in addition to dietary and medication compliance in group D to control severe HPT. Interestingly patients with low PTH (< 100) showed relative epogen resistance while patients in group D required smaller epogen doses. There was inverse relationship between ZPR & EPO dosage. The effect of ZPR on EPO responsiveness needs to be confirmed in larger study.

*Shuja, Suhail B*, Raja, Rasib M, Division of Nephrology, Albert Einstein Medical Center, Philadelphia, PA, USA.

## Effect of Dialysers on the Internal Pressure of the Eye in Hemodialysis Patients (Hemophane – Polysulphone – Helioxone)

Due to the application procedure as well as the underlying primary illness, hemodialysis is potentially capable or causing many problems concerning the eye. In this study, we planned to conduct a research on the entire ophthalmic illnesses suffered by 254 patients treated in our center and particularly on the effects of different dialysers on the internal pressure of the eye both before and after dialysis.

To this end, we conducted 1016 measurements on the said 254 patients in our center. Out of the said measurements, 330 were performed by using polysulphone, 320 by using hemophane and 366 by using Fx series Helioxone dialyser.

The internal pressure of the patients' eyes before and after dialysis were evaluated by the same physician using a non-contact tonometer. In this study, variations over 2mmHg between measurements taken before and after dialysis were considered to indicate increases or decreases.

Consequently, we found out that the type of dialyser used affects the internal pressure of the eye differently. While the Fx series helioxone and polysulphone dialysers tended to cause the internal pressure of the eye to remain constant or decrease, hemophane dialysers tended to increase the said pressure. The difference was found to be statistically significant ($p < 0.01$).

To end with, not only characteristic such as the patient's weight, the amount of liquid collected and the vascular entrance, but also the type of dialyser used play an important role on the differences of the internal pressure of the eye encountered during dialysis.

Semrin Erol, Şahin Tunali, Muhammed Seren, Ferda Şamay. Bilser Güneş., Güldehen Akbaş., Halit Erol. Fresenius Avcilar Hemodialysis Center. Istanbul, Turkey.

## An Incenter Nocturnal Hemodialysis Program—Three Years Experience

We report our experience with a program of long, slow, overnight hemodialysis (HD) performed 3 times a week in an existing dialysis facility. Beginning in April 1999, 14 chairs in one bay of our facility were replaced with beds, subdued lighting was installed, and machine alarms were decreased to minimum volume. Fresenius F60 dialyzers were selected with a $Q_B$ of 220–300 ml/min and a $Q_D$ of 400–500 ml/min. Patients dialyze for 7–8 hrs overnight. Staffing is with 1 nurse and 1 PCT for 10 patients. Standard dialysate is used, and heparin is dosed 100 U/kg at treatment initiation and again at mid-treatment. All access types are utilized. The program is open to all patients in our area. A total of 65 patients have participated, with a current census of 20 patients. Participants have tried nocturnal dialysis for a variety of reasons including work/school schedules, excessive interdialytic weight gains, inadequate dialysis (due to poor access function or large body mass), and hemodynamic instability with standard daytime HD. Blood pressure

control has improved among the participants in the program, perhaps due to more gentle ultrafiltration and improvement in maintenance of dry weight. Among 31 patients who remained on nocturnal dialysis for over 6 months, 21 started the program on an average of 2.5 antihypertensive agents (AHA). After 6 months, 9 patients no longer needed AHA while 12 patients remain on an average of 1.3 AHA. URR also improved by an average of 4.35 among 13 patients who transferred from standard incenter HD to the nocturnal program. In all, 45 patients have left the program, for reasons which include insomnia/social (15), death (9), transfer to home HD (8), renal transplantation (6), noncompliance (3), moved away (2), and other (2). In conclusion, long overnight HD can be performed in an existing dialysis facility, providing patients with another HD option. Patients who may benefit from this modality include those with daytime jobs, patients with inadequate clearance on standard HD, patients with excessive interdialytic weight gains, and those who poorly tolerate standard HD.

Radford, M. Gene, Shultman, Debra S., Pasour, Anna G., Cobb, Anne M., *Chandler, Joseph T.*; Metrolina Nephrology Associates, PA, Gastonia, NC, USA.

## Time to Hemostasis (TTH) after Needle Removal in ESRD Patients (pts) on Hemodialysis (HD) Treatment

Prolonged bleeding after needle removal post-HD sessions results in increased blood loss and prolongs waiting time between shifts in HD treatment centers. We sought to identify factors that contribute to lengthening TTH after needle removal in ESRD patients on HD in an outpatient treatment facility. TTH was determined as the average of 4 measurements in 4 separate treatment sessions. Of 163 patients consecutively studied, 120 patients had TTH $< 8$ min, defined as short TTH, whereas in 43 patients TTH was $>$ or $= 8$ min, defined as long TTH. Clinical and laboratory variables were analyzed by the Cox's proportional hazard model. The age of long TTH pts was $62 \pm 15$, similar to $58 \pm 13$ yr in short TTH pts. Long TTH pts had been on HD for $3.0 \pm 1.6$ yr, significantly longer than $2.2 \pm 1.7$ yr in short TTH pts. Blood pressure (BP) in long TTH pts was $139 \pm 19/72 \pm 11$, significantly higher than $129 \pm 16/68 \pm 9$ mmHg in short TTH pts. In long TTH pts, blood flow through the HD circuit (indicated by blood pump readings), and mean venous pressure (measured at the venous bubble trap) were $448 \pm 36$ and $241 \pm 33$, respectively, significantly greater than $436 \pm 30$ ml/min and $220 \pm 35$ mmHg in short TTH pts, and positively correlated with TTH ($P < 0.001$). AV graft was more likely than fistula to be associated with long TTH ($P < 0.0001$), as was an upper arm angioaccess compared with a forearm graft or fistula ($P < 0.002$). In pts with long TTH, the Hct was $34 \pm 4$, lower thn $38 \pm 4\%$ in short TTH pts ($P < 0.0001$), while the platelet count and the dose of heparin used during HD were similar in both groups. In the multivariate analysis, Hct, systolic BP, and AV graft were associated with long TTH. Conclusion: Higher levels of Hct, lower BP, use of an AV fistula and placement of a forearm access decrease TTH, leading to a decrease in post-HD blood loss as well as an increase in the efficiency of the HD unit.

*Sun W.Y*, Rashidi P., Bui M., Chou S.Y..Shapiro W.B. Division of Nephrology & Hypertension, The Brookdale University Hospital and Medical Center, Brooklyn, NY, USA.

## Nephrogenic Fibrosing Dermopathy and Alpha-1 Antitrypsin Deficiency: A Case Report of a Hemodialysis Dependent Man

Nephrogenic fibrosing dermopathy (NFD) is a rare newly described scleromyxedema-like cutaneous disease that occurs in renal failure patients. Since the year 2000, NFD has been identified in patients on hemodialysis, peritoneal dialysis, renal transplantation and no dialysis. Objective: To discuss the clinical presentation of a case of NFD, which compounded the course of alpha-1 antitrypsin (A1AT) deficiency. This 23-year-old man on hemodialysis thrice weekly had rapid deterioration of functional abilities. The patient was previously ambulatory, but he became contracted and bedridden over several weeks. He had a brawny thickening of his skin over his arms, legs and chest. He complained of intolerable burning joint pain during hemodialysis. After a failed trial of steroid therapy NFD was diagnosed by biopsy. He subsequently became hypercalcemic secondary to immobilization. His existing A1AT deficiency presented as liver failure, hyperammonemia and encephalopathy. He was cachetic and his nutritional status was difficult to manage due to medically induced diarrhea, poor appetite, confused mental state and infected total parenteral nutrition lines. A dual liver-kidney transplant was considered, but several factors prevented surgery including: poor nutritional status, scant data to suggest resolution of NFD after transplantation and lack of profound liver failure. His nutritional status, contractures, mental status and liver function never recovered, and six months after diagnosis of NFD the patient died. Conclusions: This case of NFD resulted in a rapid decline of function from ambulatory young man to contracted and bedridden invalid. The NFD did not respond to therapy and compounded the course of A1AT. NFD contributed to hypercalcemia of immobility, intolerance of hemodialysis and cachexia.

*Arndt, F.*, Haqqie, S., Elwell, R., Dept. of Nephrology. Albany Medical College, Albany, NY USA

## A Case of Hemodialysis Patients with Encapsulating Peritoneal Sclerosis (EPS)-like Finding

Encapsulating peritoneal sclerosis (EPS) is recognized as a serious complication of peritoneal dialysis (PD). Involvement of the inflammation is indispensable as the EPS emission factor. We experienced the surgery of the EPS-like

case that emits it to the hemodialysis (HD) patient without the PD.

Patient: In November 1996 the patients, a 47-year old male developed end-stage renal failure due to chronic nephritis and started HD. Before and during HD, he complicated alcohol liver cirrhosis with ascites. In September 2001 he had intestinal obstructive symptoms and recovered with repeated puncture and drainage of ascites. Abdominal CT examination revealed the intestine oppression by the ascites with thick tunic formation. At May 2002, he underwent a laparotomy. Thick capsules formed surroundings to the ascites. This capsules covered parietal peritoneum and intestine surface and oppressed the intestine. The total ablation of small intestine was succeeded. Ascites examinations IL-6 20,350 pg/mL FDP 80 micro-g/mL TAT 1090 micro-g/L, was suspected to conjecture the involvement of inflammation and coagulate-fibrinolysis. Histology of peritoneum showed absence of mesothelium but not fibrosis and sclerosis.

Discussion: EPS is caused by the inflammation on the deteriorated peritoneum, resulting in encapsulation after the accumulation of inflammatory products such as fibrin. Even if there is not the peritoneum deterioration, chronic inflammation and stimulation that continues for long-time causing EPS-like findings with encapsulation. The encapsulating ileus findings irrespective of the peritoneum deterioration should call with encapsulated peritonitis (EP).

*Kawanishi H*, Watanabe K, Kurayoshi M, Kawai T, Shiraki N, Arakawa T, Moriishi M, Tsuchiya S; Akane Foundation, Tsuchiya General Hospital, Hiroshima, Japan.

## Lanthanum Carbonate in the Management of Renal Osteodystrophy in Dialysis Patients

In an open label, randomized, parallel group study, we treated ten patients with lanthanum carbonate and ten patients with calcium carbonate to control their serum phosphate levels.

All patients were initiated onto dialysis within 12 weeks of recruitment to the study. They were on maintenance bicarbonate haemodialysis for 12 hours per week, with low flux polysulphone or hemophane membrane, and required phosphate control by the use of oral phosphate binders. Both phosphate binders were given with meal, divided into three equal doses. The maximum allowed daily dose of lanthanum carbonate and calcium carbonate was 3750 mg and 9000 mg, respectively. The duration of the study was one year.

Serum phosphate levels were controlled well in both groups with no difference between them. In the lanthanum group mean phosphate level varied between 1.3 and 1.9 mmol/l, whilst in the calcium carbonate group it varied between 1.3 and 1.65 mmol/l. The maximum mean daily dose reached 1450 +/− 610 mg in the lanthanum carbonate group and 2400 +/− 1400 mg in the calcium carbonate group. In both groups, serum calcium levels did not vary significantly during the study. Mean serum calcium was 2.12 +/− 0.02 mmol/l in the lanthanum carbonate group and 2.33 +/−0.09 mmol/l in the calcium carbonate group. Bone alkaline phosphatase did not significantly vary between the two treatment groups, remaining at the upper limit of the referent values. The mean value of PTH level in the lanthanum carbonate group was 33 +/−6.2 pmol/l, and differed significantly from the mean PTH level at the calcium carbonate group –23 +/− 5.9 pmol/l (PTH ref. values 1.05– 6.84 pmol/l). In the both groups the mean levels of 25 vitamin D and 1,25 vitamin D were similar and throughout the study remained at the lower limit of the referent values. Lanthanum carbonate proved a safe phosphate binder, as we noted no serious adverse events, except for sporadic, clinically non-relevant hypocalcaemia.

We could conclude that lanthanum carbonate was a safe and effective phosphate binder and it could better prevent hypercalcaemia.

*Spasovski G.B.*, Sikole A., Gelev S., Grozdanovski R., Amitov V., D'Haese P.C.* and De Broe M.E.*. Department of Nephrology, University of Skopje, Macedonia, and *Antwerp, Belgium.

## Tuberculosis Infection, a Challenge to Diagnose and Treatment in Hemodialysis Patients

PURPOSE OF STUDY: The immunologic rearrangements in chronic renal failure have increased the susceptibility to tuberculosis (TB) infection. We present our experience in the diagnosis and treatment of TB among hemodialysis patients in our centre.

METHODS: Since 1997–2001 tuberculosis was diagnosed in 26 patients (17 male, 9 female, mean age: 44.5 ± 14.3 years, HD duration 52.6 ± 34.1 months) that make an incidence of %2 per year.

RESULTS: TB infection was characterized with an insidious while the main symptoms were fever in 80.7%, weight loss in 46.1% and night sweats in 30.7% of the patients. PPD skin test was ≥ 10 mm in 46.1%, 5–10 mm in 30.8%, and anergic in 23.1% of the patients. The major site of presentation was extrapulmonary TB in 76.9% of the patients predominating as lymphadenitis in 11 patients where as there were bone involvements in 2, peritoneum 4, and liver granuloma formation in liver in 1 patient. In addition to 4 patients with pulmonary involvement, 2 patients were diagnosed to have miliary TB. Our therapy protocol included administration of morfazinamid and ethambutol for 2 months and isoniazid, rifampicin for 9 months. In patients with miliary TB streptomycin was added to therapy. Mortality rate was 15.3%, while the rest of the patients were completely cured of TB. Old age, presences of malnutrition and infection with other bacterial agents have been found to be the major factors influencing the morbidity and mortality in these patients.

CONCLUSION: There is a high incidence of TB infection in HD patients in Turkey. Insidious onset and extrapulmonary involvement are challenging problems in the diagnosis. Mortality rate is still high despite appropriate treatment.

*F.N. Ozdemir*, S. Sezer, B.H. Ozdemir, E. Agca, Z. Arat, M. Haberal. Baskent University Faculty of Medicine, Department of Nephrology, Ankara, Turkey.

## Nocturnal Hemodialysis Is Better Than Quotidian Hemodialysis

**Background**. It is unknown whether long nocturnal (6–7 times weekly 6–8 hours) hemodialysis (NHD) is better than frequent short hemodialysis ('daily', quotidian hemodialysis, QHD). **Methods**. A Dutch NHD pilot study ('Nocturne') started in December 2001. We can now evaluate effects of 4 months NHD in 14 patients. Baseline dialysis frequency was 3.5 or less ($3.13 \pm 0.23$, M ± SD) in group A ($n = 8$), and 4 or more ($5.0 \pm 0.89$) in group B ($n = 6$), weekly dialysis time was equal in both groups. **Results**. Single pool Kt/V, being higher in group B at baseline, increased in both groups (A: $3.1 \pm 0.8$/week to $9.5 \pm 2.3$, B: $3.8 \pm 1.0$ to $10.9 \pm 4.1$). Baseline nPCR, being higher in group B, increased in both groups (A: $1.0 \pm 0.3$ g/kg/week to $1.4 \pm 0.3$, and B: $1.2 \pm 0.5$ to $1.8 \pm 0.5$). Baseline albumin was higher in group B, and increased in group A ($39.6 \pm 3.7$ g/l to $43.2 \pm 1.5$), not in B ($41.4 \pm 2.3$ to $42.8 \pm 2.3$). Target weight increased only in group A ($71.8 \pm 10.5$ kg to $75.3 \pm 11.9$), not in B ($71.4 \pm 25.5$ to $71.3 \pm 26.7$). NHD resulted in normophosphatemia in both groups despite phosphate supplementation and cessation of phosphate binders. PTH decreased in both groups (A: $40.6 \pm 38.0$ pmol/l to $14.4 \pm 11.7$, B: $35.6 \pm 37.7$ to $22.4 \pm 41.5$). In both groups, pre- and postdialysis mean arterial pressure decreased (A: $106.8 \pm 7.9$ mmHg to $94.4 \pm 12.1$ and $97.3 \pm 9.5$ mmHg to $86.3 \pm 8.2$, B: $102.2 \pm 28.4$ to $89.4 \pm 9.5$ and $90.3 \pm 26.8$ to $82.7 \pm 12.9$). Antihypertensives were discontinued or markedly reduced. Fatigue, insomnia, prurigo, restlessness, appetite, physical condition, working ability and quality of life (SF36) improved significantly in both groups. **Conclusion**. This small pilot study suggests that phosphate and PTH control, blood pressure, uremic symptoms and quality of life improve when conventional hemodialysis or QHD patients switch to NHD. Nutritional parameters improve only in the previously conventionally treated group.

*Kooistra MP.* Dianet Dialysis Centres, Utrecht, The Netherlands.

## A LWMH–Tinzaparin an Efficient and Safe Product for Anticoagulation in CRRT

One of the most drawbacks of CRRT is anticoagulation. Excessive anticoagulation determines bleeding complications; whole circuit clotting decreases dialysis effectiveness, increases blood loss and necessitates transfusions. The aim of the study was to evaluate efficacy and safety of Tinzaparin as anticoagulation for extracorporeal circuit in CRRT.

The optimal necessary dose of tinzaparin was examined in 12 CRRT sessions, 7 CVVHDF (Qb = $134 \pm 15.7$ ml/min, Qd = $35 \pm 7$ ml/min, minimal UF = 500 ml/h, total time = 120.5 h) and 5 CVVH (Qb = $150 \pm 13$ ml/min, minimal UF = 500 ml/h, total time = 72.5 h) in 9 pts (M = 5, F = 4, mean age = $51.78 \pm 8.9$ y, BW = $60 \pm 15.3$ Kg) with acute renal failure and associated comorbidities. The initial dose of tinzaparin was 5 IU a Xa/Kgc in 2 pts with thrombocitopenia $< 100.000$/mm3 and 10 IU a Xa/Kgc in 5 pts without bleeding disorders, given as bolus in the arterial line at the start of CRRT, followed by an infusion of 10 IU aXa/kgc/h. Dose adjustments was made by increasing or decreasing dose with 2.5 IU a Xa/kgc/h. Anticoagulant efficiency was measure by absence or presence of clinical and pressure signs of clotting in dialyser or extracorporeal circuit. Mean dose of Tinzaparin was $540.3 \pm 114.2$ IU a Xa/h (range 400–800). Overall, Tinzaparin proved a satisfactory anticoagulation regime for all patients. In all pts clinical signs of clotting in dialyzer or lines during the CRRT sessions were absent. In 3 pts (66.6%) the dose of Tinzaparin was changed in the first five hours of CRRT sessions to prevent clotting, using pressure values. The tolerance of Tinzaparin was excellent for all dose levels used. In 1 pt (11.1%) minor hemorrhages (hemoptisis) appeard during CRRT session. No major hemorrhages appeared. Other adverse events due to Tinzaparin (thrombocitopenia) do not occurred during the study. In conclusions Tinzaparin have an excellent anticoagulation effect, preventing clotting in dialyser and extracorporeal circuit, without major adverse events, in spite the long time utilization of drug during the procedure.

*G. Ismail*, C. Ionescu, M. Rosu, A. Szigeti, M. Voiculescu. Dept. of Internal Medicine-Nephrology, Fundeni Institute, Bucharest, Romania.

## The Efficiency and Safety of an Ace-Inhibitor–Fosinopril in ESRD Patients During Dialysis

Arterial hypertension in ESRD patients during dialysis is predominantly rennin-dependent. The utilization of an ACE-inhibitor in the treatment of arterial hypertension appears to be useful in these patients. The aim of the study was to establish the antihypertensive efficiency (control of BP and reduction of cardio-vascular morbidity and mortality) and the therapeutically safety of an ACE-inhibitor (Fosinopril-Monopril®) in dialysis patients without BP controlled by Ca- blockers or beta-blockers. We studied 30 ESRD patients (M = 20, F = 10, mean age = 48.2 y, HD = 26 pts, DPCA = 4 pts) treated with Monopril 10–20 mg/d, in monotherapy in 4 pts and associated therapy in 26 pts. The mean follow-up was 18.2 months (9–36). We obtain a significantly and sustained systolic BP reduction (155.2→134.7 mmHg, $p = 0.001$) at 1,3,6,12,24,36 months ($p < 0.05$). Diastolic BP is significantly reduced at the end of follow-up (89→84.2 mmHg, $p = 0.03$) and at 3, 24 and 36 months.

The rate of cardio-vascular events was reduced: instable angina in 3.3% cases. None of our patients presents AMI, stroke, cardiac arrest or cardiac death during the follow-up. Regarding the impact on seric K level in 6.6%pts we have predialitic K level > 5.5 mEq/l. All patients were anuric, but none of them presented severe arrhythmias or needed supplementation of dialysis program.

In conclusion in ESRD patients during dialysis an ACE-inhibitor is mandatory in the treatment of arterial hypertension due to hyperreninemic feature of BP. Fosinopril-

Monopril is efficacy in BP reduction and cardio-vascular morbidity and mortality during the treatment is very low. Utilization the drug is not associated with a significantly augmentation of seric K level, including in anuric patients.

*C. Ionescu*, G. Ismail, M. Rosu, O. Iliescu, A.M. Tutea Voiculescu Dept. of Internal Medicine-Nephrology Fundeni Institute, Bucharest, Romania

## Nocturnal Home Hemodialysis Can Be Successful in Extremely Complicated Patients – A Case History.

It has been well-documented that Nocturnal Home Hemodialysis (NHH) is a superior form of treatment for patients undergoing chronic renal replacement therapy. However, documentation as to the actual type of patient suitable to perform this treatment at home is scarce. Patients who have significant comorbities have routinely received their treatment in a supervised setting (in-hospital or limited care) which is a much more expensive modality. We believed these patients could successfully perform NHH and do so at less cost.

The London Health Sciences Centre in London, Canada has recently completed a 3 year study utilizing matched cohort controls where patients have been treated with either Short Hour Daily Hemodialysis (SHDH) or NHH. Data collected includes biochemical, clinical and economical for 12 months retrospective on CH and 18 months on the selected daily therapy. Quality of Life data was obtained with disease specific questionnaires and the SF –36. Costs per Quality Adjusted Life Year was obtained with the Health Utilities Index tool. This case history of a very motivated 40 year old female with antiphospholipid antibody syndrome, bilateral amputation, uncontrolled hypertension and seizure disorder provides concrete data that not only has the cost of her health care diminished significantly (from $188,542.26 in the retrospective year to $80,249.76 Canadian dollars cost per patient year on NHH) but her Quality of Life has also dramatically improved. She was able to perform this treatment independently.

Patients currently dialyzing in supervised settings should be carefully assessed to determine if they are suitable to perform NHH and thereby experience benefits derived from the therapy. Expensive dialysis in overcrowded hospital units could also be diminshed and coupled with the approaching nursing shortage all parties will benefit.

*Leitch R*, Heidenheim P, Lindsay R, Kroeker A, Ferguson E, Clement L, Peters K. Department of Nephrology, London Health Sciences Centre, London, Canada.

## The Impact of Occasional vs Persistent Inflammation on the Survival of HD Patients

An elevated CRP level is associated with increased mortality in dialysis pts but the impact of occasional vs persistent inflammation is not known.

**Objective**: To assess the influence on survival of fluctuating vs persistent inflammation in HD pts.
**Methods**: We prospectively (bimonthly) analysed: CRP, S-Alb and fibrinogen in 180 HD pts ($49 \pm 14$ y, 54 % M, 9% DM) with a mean follow up of 21 months. The nutritional status was evaluated by SGA. According to the median of 4 consecutive measurements of CRP and by using the receiver operating characteristics to determine the criteria for inflammation, the patients were allocated into 3 groups: Group 1($n = 64$), non-inflamed (CRP $< 4.8$ mg/l); Group 2 ($n = 67$), fluctuating levels of CRP (CRP 4.8–10.3 mg/l); and Group 3 ($n = 49$), persistently inflamed (CRP $> 10.3$ mg/l). Cox proportional hazard analysis was used to assess independent predictors of survival, and mortality was analyzed by Kaplan Meier analysis.
**Results**: The median baseline CRP was 3.6 (range 3.2 to 82) mg/l. The mean $\pm$ SD concentration of fibrinogen was $42 \pm 11$, $50 \pm 12$ and $57 \pm 12$ g/l ($p < 0.001$), and of S-Alb, $35 \pm 3$, $35 \pm 3$ and $34 \pm 4$ g/l ($p = 0.3$) for Groups 1, 2 and 3, respectively. The incidence of malnutrition was 57%, 59% and 72% in Groups 1, 2 and 3, respectively ($p = 0.22$). The survival rate (Kaplan Meier) was significantly different among the groups (chi-square 11.65; $p = 0.003$). Whereas the survival in Group 3 was only 70% after 21 months, it was similar in Group 1 (91%) and Group 2 (90%). A single measurement of CRP, and age, S-Alb and malnutrition were independent predictors of mortality (Cox analysis).
**Conclusion**: An occasional elevation of CRP in HD pts appears to be relatively benign and the mortality predictive effect of a single high CRP level is therefore mainly related to its association with a persistent increase in CRP which on the other hand is a strong predictor of outcome.

Nascimento MM, Pecoits-Filho R, Qureshi AR, Manfro RC, Pachaly MA, Renner L, Stenvinkel P, *Lindholm B*, Riella MC. Pontificia Universidade Católica do Paraná, Brazil; Univ. Federal do Rio Grande do Sul, Brazil; Div. of Baxter Novum and Renal Medicine, Karolinska Institutet, Stockholm, Sweden.

## Nocturnal Hemodialysis Lowers Heart Rate during Sleep and Normalizes Its Parasympathetic and Sympathetic Modulation

Nocturnal hemodialysis (NHD) [8 hrs, 6/week] is a novel renal replacement therapy that lowers daytime blood pressure and plasma norepinephrine and corrects uremic related sleep apnea. Our aim was to test the hypothesis that NHD would lower sympathetic modulation of sino-atrial node discharge during sleep as assessed by power spectral analysis of heart rate variability (HRV). We conducted a case-control study comprising 9 patients (age: $44 \pm 2$) [mean $\pm$ SEM] before and after conversion from conventional hemodialysis (CHD) [4 hrs,3/week] to NHD and 10 normal subjects (age: $45 \pm 3$). Overnight polysomnography was used to assess heart rate, sleep stages and episodes of apnea and hypopnea per

hour of sleep. Fast Fourier transformation was employed to compute frequency domain analysis of HRV (low frequency (LF) [0.05–0.15Hz] and high frequency (HF) [0.15–0.5Hz] power) during stage 2 non rapid eye movement sleep. LF/LF + HF, HF/HF + LF and LF/HF were used to estimate sympathetic and vagal modulation of heart rate and their ratio respectively. While on CHD, each subject was examined twice (1 day prior to and same night of CHD session). After conversion to NHD, each patient was studied once, on a non-dialysis night. Frequency of apnea and hypopnea decreased significantly after conversion from CHD to NHD (from $29.2 \pm 9.9$ to $7.2 \pm 3.3$ episodes per hour, $p = 0.04$).

| *Subjects* | *RR interval (ms)* | *HF* | *LF/HF+LF* | *HF/HF+LF* | *LF/HF* |
|---|---|---|---|---|---|
| Normal | $1027 \pm 44$ | $6726 \pm 4556$ | $0.42 \pm 0.04$ | $0.42 \pm 0.05$ | $0.71 \pm 0.11$ |
| CHD-1 day prior | $776 \pm 53^{a}$ | $100 \pm 45^{a,b}$ | $0.60 \pm 0.08$ | $0.14 \pm 0.02^{a,b}$ | $2.17 \pm 0.54^{a,b}$ |
| CHD-same day | $746 \pm 38^{a}$ | $48 \pm 15^{a,b}$ | $0.59 \pm 0.10$ | $0.17 \pm 0.05^{a,b}$ | $3.57 \pm 1.81^{a}$ |
| NHD | $916 \pm 67$ | $712 \pm 256$ | $0.39 \pm 0.06$ | $0.32 \pm 0.07$ | $0.75 \pm 0.22$ |

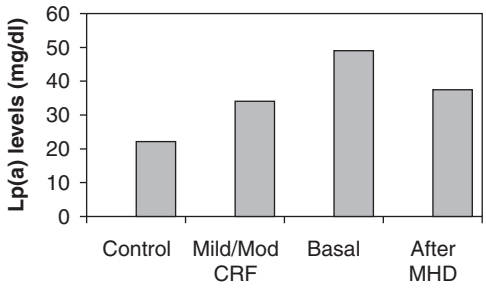
[a]:$p < 0.05$ compared to normal controls, [b]:$p < 0.05$ compared to NHD

Compared to normal subjects, CHD patients had diminished RR interval and HF spectral power. Both variables increased significantly after conversion to NHD. The ratio of LF/HF indicated significant greater sympathetic modulation of HRV in patients undergoing CHD. Normalization of this ratio occurred after conversion to NHD. Vagal modulation of heart rate is decreased during sleep in end-stage renal disease patients, causing sympathetic modulation to predominate. These abnormalities of autonomic regulation during sleep are restored towards normal by NHD. Two potential mechanisms for this are removal of a sympatho-excitatory stimulus from the uremic kidney, and a reduction in sympathetic surges caused by apnea during sleep.

*Chan CT*, Hanly P, Gabor J, Picton P, Pierratos A, Floras JS. University of Toronto, Toronto, Ontario, Canada.

## Lipoprotein (a) in CRF: Effect of Maintenance Hemodialysis

Coronary artery disease is a major cause of morbidity and mortality in patients with chronic renal failure (CRF). Besides the higher prevalence of traditional risk factors, several uremia-related factors may play a role. Although lipoprotein (a) [Lp (a)] is largely determined by genetic factors, there is some evidence to suggest elevated levels of Lp (a) in patients with CRF. However, the effect of maintenance hemodialysis (MHD) on Lp (a) levels has not been studied. Objective: To evaluate the profile of serum Lp (a) and carotid intima-media thickness (IMT) in patients with various grades of CRF and to study the effect of MHD on Lp (a) levels in patients with advanced CRF. Methods: The study group comprised of patients with mild to moderate CRF (n = 15) and advanced CRF (n = 15). Fifteen healthy controls were also enrolled. Serum Lp (a) level was measured and carotid doppler study was done in all cases. In patients with advanced CRF serum Lp (a) level was again measured after one month of MHD. Results: Serum Lp (a) showed a progressive rise with increase in severity of CRF. As against 20% controls, 60% of patients with mild-moderate CRF and 73% of patients with advanced CRF had Lp (a) levels more than 30 mg/dl. In patients with advanced CRF, repeat Lp (a) levels after 4 weeks of MHD showed a decline by 23.6% with a range of 2.5%–50% ($p < 0.001$) (Figure) However there was no significant difference in the carotid IMT amongst the three groups. Conclusion: Patients with CRF have significant elevation of Lp (a) level. This lipid abnormality starts early during the course of CRF and shows progressive worsening with increase in severity of CRF. In patients with advanced CRF, MHD results in significant decline in Lp (a) levels.




*Kalra OP*, Khaira A, Gambhir JK, Agarwal S., Bhargava SK. Dept. of Medicine, Biochemistry and Radiology, University College of Medical Science and GTB Hospital, University of Delhi, India.

## Indicators for Recovery of Renal Function

Although guidelines for initiation of dialysis in End Stage Renal Disease (ESRD) patients are established, little is known about indicators of recovery of renal function. Renal function of dialysis-dependent (DD) patients is seldom followed and when renal function begins to normalize, it may be attributed to malnutrition. We studied a group of DD patients who recovered renal functions and were taken off dialysis.

Eight patients with mean age of $53.8 \pm 6.7$ years ($\pm$ SEM) were identified. Four were male. Three were Caucasian, 3 African American, 1 Asian and 1 Hispanic. The cause of renal failure was focal segmental glomerulonephritis (FSGS) in 4 patients, atheroembolism or contrast nephropathy in 2 patients, membranous glomerulonephritis in 1 patient and vHIV nephropathy in 1 patient. Six patients had uremic symptoms, 1 had rapidly declining renal function and 1 had refractory anasarca. The mean duration on dialysis was $11.1 \pm 4.2$ months. Four patients had either acute renal failure or acute on chronic renal failure. All had good urine output

and 3 had no symptoms on dialysis. The other 5 could not tolerate dialysis due to symptoms. Three patients had normal serum chemistries. Their pre-initiation creatinine was $5.21 \pm 0.6$ mg/dl and BUN of $72.12 \pm 11.12$ mg/dl. These patients remained without dialysis for $19.75 \pm 5.97$ months. The mean creatinine after cessation of dialysis was $2.85 \pm 0.57$ mg/dl and BUN was $29.62 \pm 5.26$ mg/dl, while the mean creatinine clearance calculated by 24-hour urine collection was $29.75 \pm 4.78$ ml/min. One patient who was transferred to other facility died due to HIV complications. All patients except 1 who had to reinitiate dialysis after nine months continue to enjoy a dialysis free life.

We therefore suggest that ESRD care providers should be aware of the possibility of recovery of renal function, especially in those who have significant urine output and those with acute renal failure. Dialysis intolerance should be considered a potential indicator of recovery of renal function.

*Nair V*, Agraharkar M. Department of Medicine, Nephrology Division, University of Texas Medical Branch, Galveston, TX, USA

## Home Hemodialysis: Associations with Modality Failure

**Purpose**: To determine risk factors for home hemodialysis (HH) failure.

**Methods**: We conducted a prospective study from 12/2000 to 9/2002 using data from the 1709 patients who received renal replacement therapy at the Northwest Kidney Centers (NWKC). Prevalent and incident Home Hemodialysis (HH) patients were included in the analysis. Baseline demographics, date of entry and date of exit from HH were ascertained for all patients. Differences among groups were assessed by independent t-test for continuous variables and by chi-squared test for categorical variables. Risk of HH failure was assessed with logistic regression.

**Results**: Of the 116 patients who initiated training in the NWKC HH program (6.8%), 77.7% remained in the HH program, 10.3% received a transplant and 10.3% returned to in-center dialysis. Compared to patients who received a transplant or returned to in-center dialysis, HH patients were more likely to be older (65 vs. 54 yrs, $P < .05$) and were on dialysis longer ($3.8 \pm 4.7$ vs. $2.3 \pm 3.0$ yrs, $p < 0.05$). Ethnicity, gender, primary renal disease and helper status were similar between groups, and were not associated with increased risk of HH failure. Unadjusted 3-year mortality was 31.7% for HH patients. HH patients who died were more likely to be older ($p < 0.05$) and to have diabetes ($P < 0.01$) than those who returned to in-center dialysis or who received a transplant.

**Conclusions**: In HH patients, older age but not ethnicity, gender or helper status was associated with treatment failure. Older age and diabetes remain risk factors for mortality in the HH population.

*Young BA*[1,2], Hynes J[2], McComb T[2]. [1]Department of Medicine, University of Washington, [2]Northwest Kidney Centers, Seattle, WA, USA.

## Similar Increase Plasma Asymmetric Dimethylarginine (P-ADMA) and in Non Renal patients with Abnormal Myocardial Perfusion and in Hemodialysis Patients.

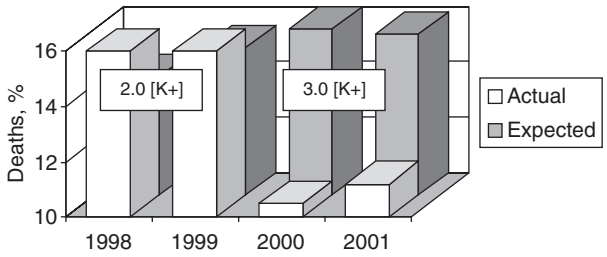
A high plasma level of ADMA, an endogenous inhibitor of nitric oxide synthase, that is thought to be a novel biochemical marker for atherosclerosis in non-renal patients, is recently reported to be associated also with increased atherosclerosis and increased cardiovascular mortality in chronic renal failure (CRF) patients. **Objective**: A comparative analysis of P-ADMA levels in hemodialysis (HD) patients, in non-renal patients with verified ischemic heart disease and healthy controls. **Methods**: P-ADMA was measured by HPLC (Anderstam et al JASN 8:1437–42, 1997) in 103 HD patients (Group 1; $49 \pm 14$ years, 55% M) in 30 non renal patients (Group 2; $62 \pm 12$ years, 80% M) with myocardial perfusion defects diagnosed by Stress/Rest Gated Single Photon Emission Computed Tomography (GSPECT) and in 21 healthy controls (Group 3; $32 \pm 10$ years, 52% M). **Results**: Increased median levels of P-ADMA were observed in both the HD patients (0.48 (range, 0.03–2.41) umol/l; $p < 0.001$) and in the patients with abnormal GSPECT (0.47(range, 0.01–1.43) umol/l; $p < 0.01$) compared with the controls (0.3, range 0–0.78 umol/l). There was a positive correlation between P-ADMA and C-reactive protein (CRP) in Group 1 ($Rho = 0.34$, $p = 0.05$) but not in Group 2. **Conclusions**: The presence of a similar increase in P-ADMA levels in Group 1(HD patients) and Group 2 (with verified ischemic heart disease) compared with the healthy controls (group 3) and the correlation between P-ADMA and serum CRP in Group 1, may indicate that increased P-ADMA levels is a risk factor for inflammation related cardiovascular disease in hemodialysis patients.

Hayashi SY, Nascimento MM, Rodriguez E, Reason ITM, Custódio G, Yamada A, Qureshi AR, Stenvinkel P, Saha S, Pecoits-Filho R, Anderstam B, Riella MC, *Lindholm B.* Div.of Baxter Novum and Renal Medicine, Karolinska Institutet, Huddinge University Hospital, Stockholm, Sweden; Centro de Radioimunoensaio e Medicina Nuclear do Paraná, Curitiba, Paraná, Brazil. Pontificia Universidade Catolica do Paraná, Brazil.

## High [K+] Dialysate (3mEq/l) Improves Survival in Hemodialysis (HD) Patients

**Introduction**: Excessive K+ removal and hypokalemia following HD with standard bath (K+2 mEq/L) might be responsible for elevated cardiovascular risk in end-stage renal disease (ESRD) patients. In support of this contention, we have previously documented that HD using a dialysate [K+] of 3.0 mEq/L increases urea removal (JASN 9:2124, 1998) and lowers rebound hypertension (AJKD 26:321, 1995) after treatment, while minimizing K+ deficiency. **Objective**: To compare 1) expected death rate with standard bath to study protocol; and 2) mortality rates within our unit when [K+]d was changed from 2 mEq/L to 3 mEq/L. **Methods**: 57 patients received HD with standard dialysate

[K+] concentration of 2.0 mEq/L through May, 2000. Starting in June, 2000, standard [K+] bath was changed to 3.0 mEq/L. Other treatment parameters remained unchanged. **Results**: As shown in the figure, the actual death rate decreased coincident with the change in [K+] bath, even though the expected death rate, corrected for patient age, sex, race, and incidence of diabetes, increased slightly. Hyperkalemia did not occur after dialysate [K+] was increased, with average pre-HD serum [K+] of $4.76 \pm 0.48$ mmol/L. **Conclusion**: Routine use of dialysate [K+] of 3 mmol/L is associated with improved survival in patients with ESRD.




*Khraish GH*, Adrogue HJ., Dolson GM., Baylor College of Medicine, Houston, TX, USA.

## Nocturnal Dialysis - The 1st Australian Experience

The first government-funded, home-based, 6 night/wk nocturnal haemodialysis (NHDx) program outside North America was begun in Australia in July 2001. 14 pts, 13M:1F, mean age 47 (range 23–67) have trained to September 2002. 10/14 home dialyse 8–9 hrs/night, 6 nights/wk, (mean 50 hrs/wk), one being transplanted at 3.5 mths. 2/14 dialyse 8–9 hrs alternate nights thus are excluded from further analysis. A further 2/14 withdrew for social reasons. There have been no deaths. All 10 NHDx pts use 1.6 or $1.8\,m^2$ low-flux dialysers with a cross-over to high flux planned. Mean $Q_b$ is 250 ml/min and $Q_d$ is 300 ml/min. A mean UF rate $< 250$ ml/hr avoids intra-dialytic hypotension. Water is R/O filtered to AAMI standards. 3/14 entered from 2nd daily daytime home HDx (mean 13.3 hr/wk) and 8/14 from daytime satellite dialysis $3 \times 4 - 4.5$ hrs/wk.

5/10 NHDx pts have partners though 6/10 dialyse unpartnered during sleep. 5/10 now work full-time and 3/10 part-time, where previously, only 1/10 worked full-time and 3/10 part-time. To September 2002, experience totaled 348.5 pt wks (mean 31.7 wks/pt: range 3–57 wks). All ceased $PO_4^{=}$ binders at entry. 8/10 ceased anti-hypertensives, 2/10 remaining on a single agent. No fluid or dietary restrictions apply. Potassium intake is entirely free. Dialysate $PO_4^{=}$ must be added ($Na_2PO_4$ as Fleet® enema) to prevent hypophosphataemia. A 1.5 mmol/l calcium dialysate and calcitriol maintain a high-normal serum $Ca^{++}$.

Mean before (B) and after (A) dialysis biochemical data includes: Creat (B) 437: (A) 128 $\mu$mol/l; Urea (B) 10.1: (A) 1.9 mmol/l; $K^+$ (B) 4.5: (A) 3.4 mmol/l; $PO_4^{=}$ (B) 1.5: (A) 0.77 mmol/l; $Ca^{++}$ (B) 2.6: (A) 2.6 mmol/l. PTH has halved and EPO dose are falling. $Fe^{++}$ status is stable while the mean Hb is 119 gm/l. The mean albumin is 38 g/l

All 10 report normal restorative sleep. All 5 partners report stable self-sleep patterns while noting improved sleep, mood, cognitive function, and marital relationships in their NHDx partners. None would willingly return to conventional haemodialysis.

*Agar JWM*, Somerville CA, Simmonds RE, Boddington JM, Waldron CM. Renal Unit, Geelong Hospital, Barwon Health, Geelong, Victoria, Australia

## Rinsing Dialyzers without Heparin in Hemodialysis (HD) with Low-Molecular Weight Heparin (LMWH)

Saline plus unfractionated heparin (UFH) is routinely used for priming dializers before HD start.

The aim of this study is to assess if heparin is necessary in pre-rinsing procedure of extracorporeal systems, anticoagulated with LMWH.

We carried-out a prospective study in 14 stable HD patients, aged $58.5 \pm 3.6$ years old. All patients were treated by standard bicarbonate HD, 3 sessions × week, HD time $220 \pm 12$ min, Qb $276 \pm 21$ ml/min, low-flux dialyzers (polisulfone 5, cellulose diacetate 9). Clotting was prevented with a single bemiparin (LMWH) bolus $2900 \pm 140$ IU. Three rinsing protocols were applied in three consecutive weeks: 1st week- Saline 1000 ml + LMWH 2500 IU. 2d week- Saline 1000 ml + UFH 5000 IU. 3th week- Saline 1000 ml.

Anti-Xa activity (IU/ml) was measured at each HD (at 10 min/end). Clotting events and post-HD AVF hemostasis were recorded in a semiquantitative scale.

No significant statistical differences (Anova) were found in anti-Xa heparin activity (IU/ml) among the three rinsing protocols tested:

| | 10 min (NS) | End (NS) |
|---|---|---|
| 1st week | $0.81 \pm 0.16$ | $0.55 \pm 0.43$ |
| 2nd week | $0.76 \pm 0.21$ | $0.58 \pm 0.16$ |
| 3th week | $0.86 \pm 0.14$ | $0.64 \pm 0.16$ |

No differences were observed in drip chamber or dialyzer appearance after HD. Massive clotting was not recorded. No important bleeding was observed at stick needle sites.

In conclusion, HD performed with LMWH no needs heparin in rinsing solution. The procedure is effective and safe.

A. Cabezas, E. Martínez, J. Martínez, A. Herreros, T. Doñate, A. Oliver*, E. Andrés. Nephrology. Dialysis Unit, *Hematology. Fundació Puigvert. Barcelona. Spain.

## On the Influence of Ultrapure Dialysate on Blood Pressure and Arrythmia During Daily Hemodialysis

Biocompatible membranes have many fewer biological effects on blood during dialysis, but neither subjective nor objective symptoms are better than on bio-incompatible membranes. We speculated that small molecular impurities in conventional dialysate (conv) may offset the advantage and tested this by changing patients from regular dialysate with both cellulosic (Cell) and polysulphone (Poly) membranes to Poly membranes with ultrapure dialysate, the Aksys PHD (PHD). We followed blood pressure and pulse changes and episodes of hypotension, and arrhythmia in 23 patients during each of 4459 daily dialyses. Patients changed from Cell + conv to PHD and from Poly + conv to PHD. The purity of dialysate was checked with the limulus test with varying sensitivity. Regular dialysate failed European (57%) and USA standard (37%) in 123 samples. PHD dialysate passed twice European standard ($< 0.125$ EU) in all 194 samples On ultrapure dialysate, there were statistically fewer hypotensive crashes (14.4% vs., 8.9%) and episodes of irregular pulse (2.0% vs. 0.1%). Vital signs were also much more stable on ultrapure dialysate irrespective of what membrane was used:

| | *Cell to PHD* | | *Poly to PHD* | | *Cell to Poly* | |
|---|---|---|---|---|---|---|
| N: | 1260 | 2390 | 433 | 376 | 1260 | 433 |
| Fall in BP syst | $15 \pm 21$ | $9 \pm 21$ | $27 \pm 18$ | $2 \pm 21$ | $5 \pm 21$ | $27 \pm 18$ |
| Fall in BP diast | $5 \pm 13$ | $2 \pm 12$ | $12 \pm 9$ | $-1 \pm 10$ | $5 \pm 13$ | $12 \pm 9$ |
| Post PR | $86 \pm 15$ | $82 \pm 16$ | $78 \pm 13$ | $72 \pm 11$ | $86 \pm 15$ | $78 \pm 13$ |
| Tachycardia > 90/min | +7% | −2.6% | +15% | +3% | +7% | +15% |

All $p < 0.0001$.

These observations confirm that by themselves, a biocompatible membranes confers no clinical advantage but when used with ultrapure dialysate, patients benefit greatly. Biocompatible dialysis needs both a biocompatible membrane and ultrapure dialysate.

*Kjellstrand C*, Blagg CR, Twardowski Z, Bower J. Aksys Ltd., Lincolnshire, IL, USA, NWKC Seattle, WA, USA, U. Missouri, Columbia, MO, USA, U. Mississippi, Jackson, MS, USA

## Stress Is Very High in the Old Hemodialysis Patients and Accurately Predicts Their Outcome

The mortality rate in dialysis is very high and extreme in older patients. The 10-year survival is less than 5% in those above 60 years. We thought the stress reaction accompanying dialysis may be particularly high in the older patients with their more fragile cardiovascular system. Methods: We measured ANP and NPY levels in 33 hemodialysis patients Mean age $\pm$ SD $= 60 \pm 11$ years, and followed them for up to 12 years (Mean $\pm$ SD $= 47 \pm 45$ months ). We created a stress-index by adding NPY $\times 3$ to ANP levels. Results: Stress index Mean $\pm$ SD $= 275 \pm 152$ ng/L. 18 patients died. In Cox proportional hazard analyses, the stress index was highly predictive of death, those with an index below mean had a RR of death of only 0.221, (CI. $0.076 + 0.664$, $p = 0.006$) when compared to those with an index above mean. In stepwise analysis, the index was the only factor necessary to predict survival when run with 17 other variables. The stress index was correlated to age, Stress index $=$ age $\times 5.3 + 43$, ( $p = 0.026$). Patients above age 60 years had a stress index of $317 \pm 143$ compared to $218 \pm 149$ below age 60 ($p = 0.063$).. 50% of the old patients with a high stress index were dead at 22 months compared to 101 months for those with a low index. Att six years all patients above age 60 years and with a high stress index had died compared to 40% of those with a low index $p = 0.025$. Conclusion: Stress reaction to dialysis is the most important variable predicting death and is particularly high in the old. Present hemodialysis regimens are very stressful and unsuitable for many older patients and should be changed to daily, slow and longer treatment.

Odar-Cederlöf I, Ing T, and *Kjellstrand C.* Karolinska Institute, Stockholm, Sweden, and Loyola Medical School, Chicago, IL, and Aksys Ltd., Lincolnshire, IL, USA.

## Costs of Quotidian Home Hemodialysis

One of the deterrents to more widespread adoption of quotidian dialysis is concern over increased supply and equipment costs.

Purpose: Operating costs for short-hour daily (SHD) and slow nocturnal hemodialysis (NHD) were compared with those of conventional hemodialysis patients (CHD).

Methods: 10 SHD, 12 NHD and 22 matched CHD patients were enrolled in the study for 18 months. Costs were tracked in two groupings: Patient Measured (PM- dependent on patient's health status) and Support Modeled (SM- system costs to support all patients). A retrospective analysis of the previous year's PM costs was also performed.

Results: SHD patients saw an increase in PM costs, as treatment supply increases were not offset by decreases in consults, drugs, hospitalizations and lab tests. NHD patients saw their total PM costs drop as drug, consults and lab savings more than offset higher supplies costs. CHD patient study costs were between the SHD and NHD values. SHD and NHD achieved lower SM costs due to savings in RN and other labor expenses that more than offset higher machine, water and biomedical costs. Note that substantial variance coupled with small sample size prevented achievement of statistically significant values.

| *Costs* | *Daily (SHD)* | | *Nocturnal (NHD)* | | *Control (CHD)* |
|---|---|---|---|---|---|
| *($Can)* | *Retro* | *Study* | *Retro* | *Study* | *Study* |
| PM | 38,290 | 40,691 | 53,028 | 47,411 | 33,923 |
| SM | 38,765 | 26,590 | 38,765 | 26,960 | 38,765 |
| Total | 77,055 | 67,281 | 91,793 | 74,371 | 72,688 |

Conclusions: SHD and NHD patients appeared to achieve clinical benefits compared to CHD patients while reducing total PM and SM cost.

*Kroeker A*, Clark W.F., Heidenheim A.P., Kuenzig L., Leitch R., Lindsay R.M., Meyette M., Muirhead N., Ryan H., Welch R., White S. London Health Sciences Centre, Renal Program, London, ON, Canada.

## Nocturnal Haemodialysis – A Preliminary Cost Comparison with Conventional Haemodialysis in Australia

A 6 night/wk, home-based, government funded nocturnal haemodialysis (NHDx) program, believed to be the first outside North America, commenced in July 2001. Previously published Canadian and US costs suggest NHDx to be more cost-efficient than conventional haemodialysis (CHDx) as, although consumable-expensive, NHDx is home-based and is thus highly infrastructure, wage and hospital inpatient bed-day efficient. Comparable Australian cost evaluation is essential, however, before NHDx is widely encouraged as a new modality here.

Cost comparisons for 3 × wk CHDx vs preliminary costs for 9/12 pts on 6 × wk NHDx (3 excluded for inadequate program time) include: consumables/fluids CHDx @ $A8781/pt/yr vs NHDx @ $A17562/pt/yr; estimated nursing costs CHDx (62.25 nurse hrs/wk with a nurse/pt ratio of 3:9) @ $A12666/pt/yr vs NHDx (40 nurse hrs/wk with a nurse/pt ratio of 1:9) @ $A8111/pt/yr with projected reduction to A$4866 for nurse/pt ratio of 1:15; pharmaceutical costs (includes all medication & Fleet® for dialysate $PO_4^=$ but excludes EPO/iron polymaltose) CHDx one month prior to NHDx @ $A1412/pt/yr vs NHDx costs after one month starting home-based treatment @ $A1273/pt/yr. Though the NHDx pts have been carefully selected, only 3 hospitalizations for a total of 4 bed-days have been necessary in 348.5 pt wks of experience to September 2002.

Our preliminary cost analyses confirm prior North American data. Cumulative financial modeling shows NHDx is more costly than CHDx at low pt numbers, reaching approximate equivalence @ 12 pts and progressively dropping below CHDx costs thereafter. NHDx appears cost-competitive with CHDx whilst yielding superior biochemical, life-style and rehabilitation results (see accompanying clinical data abstract).

*Agar JWM*, Somerville CA, Simmonds RE, Boddington JM. Waldron CM. Renal Unit, Geelong Hospital, Barwon Health, Geelong, Victoria, Australia.

## Performance Evaluation of a Dialyzer Equipped with a Hydrophilic Fiber Spacer to Enhance Internal Filtration

Dialyzers equipped with a hydrophilic fiber spacer have been newly introduced in order to enhance internal filtration. The spacer is composed of a dialysis membrane bundle with several turns of the fibers wounding around it. Swelling of the spacer by absorption of water reduces the cross-sectional area of the dialysate stream and increases the pressure drop ($\Delta$PD) on the dialysate side of the dialyzer. In addition to diffusive transport, the internal filtration induced by increasing $\Delta$PD enhanced convective transport of the solute through the dialysis membrane, especially of relatively large molecular weight substances. We examined the performance of the newly introduced dialyzer in an experimental study using an aqueous solution of myoglobin and assessed the solute removal characteristics of the dialyzer with an analytical model.

Three dialyzers with the spacer at different positions were used. The 40 mm wide spacer was inserted at the inlet (40 mm inlet), the center (40 mm central), and the outlet (40 mm outlet) of the dialyzer. The results of the experimental study showed that all dialyzers containing the spacer had a higher $\Delta$PD than the control dialyzer (FB-150UH, Nipro Corp.). On the other hand, the 40 mm central dialyzer yielded higher myoglobin clearance than the 40-mm-inlet and the 40-mm-outlet dialyzers. The 40 mm central dialyzer had a higher average transmembrane pressure (TMP), because it had enough length before and after the spacer.

*Michio Mineshima*[1], Yuko Niwayama[2], Isamu Ishimori[1], Minoru Hirose[2], Satoshi Watanabe[2], Takashi Akiba[1], Takashi Sunohara[3], Toshiaki Masuda[3]. [1]Division of Blood Purification, Kidney Center, Tokyo Women' Medical University, [2]Clinical Engineering, School of Allied Health Sciences, Kitasato University, [3]Nipro Corporation, Tokyo, Japan.

## Pegylated Interferon-$\alpha$2a Kinetics during Experimental HD: Impact of Permeability and Pore Size of Dialyzer

**Aims:** To investigate changes in Pegasys blood levels in an experimental HD circuit during an "in vitro" HD session. In case that Pegasys levels change, to discern whether these changes are due to membrane clearance or adsorption. To assess the dynamic changes of Pegasys levels during the HD session and the impact of membranes with different permeability and pore size. Secondary, to compare Pegasys with other pegylated and nonpegylated -IFN. ***IFN preparations used***: Pegasys (PEG-IFN-$\alpha$2a): dose of 135 $\mu$g, Roferon (IFN-$\alpha$2a) 18 MUI, Pegintron (PEG-IFN-$\alpha$2b): dose of 100 $\mu$g (equivalent to the expected blood level measured in pts under active IFN treatment). ***Dialyzers***. Polymethylmetacrylate (PMMA) dialyzers (Toray Ind., Japan) 1,6 m2 surface have been used : B3A type: pore size of 25 Å and (low UF flux), BKP type:of 60 Å and (high UF flux) and BKF type: pore size of 100 Å and (UF rate of 25 ml/$m^{2/}$mm Hg). ***HD circuit***: All experiments were conducted under exactly the same conditions.employing the same HD machine (Toray) with controlled UF and bicarbonate dialysate. Closed circuit was established and the amount of IFN was injected in the blood bag (discarded for self-transfusions), homogenized and a pilot sample taken before the blood was recirculated

throughout the HD circuit. The liquid ultrafiltrated was replaced for the circuit remains constant. Each experiment consists of a 3 hours conventional HD with standart parameters. Monitoring: venous presure, dialysate presure. ***Sampling***. Pilot sample: (blood bag after IFN injection to measure IFN levels (no.1). 2 min. following establishment of the HD circuit, 15 min, 1 h, 2 h, and 3 h arterial and venous side. UF sample for 15 min and dialysate every hour. Blood samples are centrifuged, the plasma is isolated and then stored at 4 °C until measurement of IFN-$\alpha$levels. The ELISA employed to quantitate IFN-$\alpha$blood levels is sensitive (detects reliably as low as $< 5$ pg/ml, that is at least 1 IU/ml). **Summary of findings**. In the HD circuit described Pegasys is not cleared through either low flux (B3A) or high flux (BKP). Arround 50% of Pegasys is cleared through a dialyzer with (BKF).The changes observed in the levels of Pegasys using BKF are apparently due to flow-through clearance rather than adherence to the dialyzer. Compared with Pegasys, Roferon (the non-pegylated IFN-$\alpha$2a) and Pegintron (peg-IFN-$\alpha$ 2b) is washed-out within the 2 first hour of HD when using dialysers with either high flux (BKP) or (BKF). Through low flux (B3A) dialysers Roferon is not cleared sig. ***Conclusions***: Pegasys is not cleared through either low flux (pore size: 25Å) or high flux (pore size: 60Å) PMMA dialyzers. Roferon and Pegintron are washed-out through high flux PMMA dialysers. The BKF clears completely Roferon and Pegintron but only partially Pegasys.

*Barril G.*, Quiroga J.A.*, Sanz P., Selgas R., Carreño V.*. Department of Nephrology, Hospital U. Princesa, *FEHV, Madrid, Spain.

## On-line Monitoring of Nocturnal Home Hemodialysis

**Background**. Nocturnal home hemodialysis (NHD, 6–7 times weekly 6–8 hours) is a promising dialysis modality. On-line distant monitoring is complicated and expensive, and its usefulness should be evaluated. **Methods**. Since December 2001, 15 patients were included in a Dutch NHD project ('Nocturne'). So far, 3 patients received a renal transplant. Patients are assisted by their spouses. The dialysis machine is connected through the public telephone network by a bedside node and routers to the server in a call center. All patients received a dedicated ISDN-connection. Alarms produced by the machine are detected in the call center. For each type of alarm, a period is defined during which the patient can solve the problem. When the alarm continues after this period, the call center will notify the patient. **Results**. During 4 months, approximately 900 alarms in 1300 dialysis treatments were produced. In only 11 of 900 cases, the partner had to wake up the patient because he/she did not hear the alarm. The call center had to call 13 times, always because the patient resumed sleeping after the end of the treatment. No intervention because of serious problems was required. A majority of patients and personnel consider on-line monitoring nevertheless important as it gives a sense of safety. Additionally, nurses use the real-time connection frequently to check running dialysis treatments. Also, the system enables automatic saving of important treatment data in an electronic patient file. The experience so far is used to design a so-called 'secure bitpipe' for homecare applications, with emphasis on privacy, safety, security and effectivity. **Conclusion**. On-line monitoring of NHD may not be crucial, but enables good coaching of patients and gives a sense of safety.

*Stokvis SJA*, Verhallen AM, Meijer P, de Graaff MP*., Kooistra MP. Dianet Dialysis Centres, Utrecht, and *TNO, Institute of Applied Physics, Delft, The Netherlands.

## Water Treatment in the Home Hemodialysis Setting: Use of Recirculators Decrease Bacteria and Endotoxin Contamination

Water for home hemodialysis is treated using carbon filtration and a series of deionization (DI) tanks. These systems are practical and insure quality product water. The main drawback is susceptibility to bacterial contamination and growth. In an effort to control bacterial growth and endotoxin production in our training rooms and patient homes, our DI systems are being equipped with recirculators consisting of a pump and a flow switch. The pump maintains water in constant recirculation through the DI tanks and lines. This pump was selected to prevent overheating of the water in the system during recirculation, thus helping to prevent bacterial growth. The flow switch is a safety device that stops the pump if the flow rate drops below a preset value while also preventing the pump from overheating should the system develop a leak. The plumbing of this system prevents untreated water from bypassing the DI tanks, while the water quality remains monitored at the product port. We began using recirculators in March of this year in our training rooms. Our results have improved from 7 sets of cultures requiring an action, per AAMI standards, in 8 patient months prior to recirculator installation, to the need to re-sanitize one system, one time since recircultor installation during the ensuing 11 patient months. We currently have 3 recirculator systems (out of 8 DI home systems) in patient homes. One patient on rural water had AAMI action levels with 8 sets of cultures since January, 2002, prior to recirculator installation. He has experienced no action level needs since installation in early August. Aside from home installation problems with the initial patient, recircultors have resulted in no AAMI action levels over the past 6 patient months.

*Bender W*, Torres M, Kechker E, Pitner-Keller K, Galan C. DCI Kansas City, Kansas City, MO, USA

## Does Very Low Dialysis Endtoxin Level Influence the Plasma Pentosidine Levels in Dialysis Patients?

In order to confirm whether or not very low endtoxin level in dialysate influences the formation of advanced glycation

end products (AGEs) in dialysis patients, plasma pentosidine were determined in the dialysis patients before and after the switch to new water-supply system. Method: Plasma pentosidine were measured by high-performance liquid chromatography in 84 patients on long-term hemodialysis before 3 month, 6 months after the switch of dialysate endtoxin level from 0.020–0.025 to 0.001 EU/ml. Endtoxin measurement was done by the Wellreader SK603 (Seikagaku Kogyo Co. Tokyo) by which detection limit is less than 0.001 EU/ml.

The plasma pentosidine levels fell from $1.55 \pm 0.61$ nmol/ml to $1.38 \pm 0.52$ nmol/ml (3 month after, $p < 0.0001$) and $1.31 \pm 0.50$ nmol/ml (6 month after, $p < 0.0001$). The fall in plasma pentosidine levels were equally observed in patients given dialysis with high-flux polysulfone, PMMA, and cellulose acetate membranes. Unexpectedly, the plasma triglycerides levels fell from $150 \pm 116$ mg/dl to $124 \pm 79$ mg/dl (3 month after, $p < 0.01$) and $119 \pm 75$ mg/dl (6 month after, $P < 0.01$). The levels of total cholesterol, c-reactive protein, $\beta_2$-microglobulin did not change during this study.

Conclusion: Water purity of dialysis fluid has an impact on AGE formation and improve a status of lipid metabolism in hemodialysis patients even if endtoxin level was very low.

*Saito A*, Izuhara Y, Saito K, Ono T, Miyata T., Kurokawa K. The Institute of Medical Science, Tokai University and Ohne Clinic, Kanagawa, Japan.

## Acute Postdialysis Changes in Plasma ICAM-1 and IL-1 Levels in Hemodialysis Patients

Fifty subjects: 20 controls and 30 hemodialysis patients were included in the study. The acute changes in plasma ICAM-1 and IL-1β levels immediately after dialysis were evaluated using two types of membranes and two types of dialysate.

The predialysis ICAM-1 level in the whole patients was significantly higher than controls, while that of IL-1β was significantly lower. The postdialysis ICAM-1 showed insignificant higher level than the predialysis one, while that of IL-1β showed significant higher level than both the predialysis and control levels.

Both postdialysis ICAM-1 and IL-1β levels in patients using cuprophane membrane (bioincompatible) showed insignificant higher levels than in those using polysulfone one (biocompatible). The percent increase in ICAM-1 level did not significantly differ in these two subgroups, while the percent increase in IL-1β level showed significantly higher value in those using bioincompatible membrane (108%) than that in those using biocompatible membrane (44%).

No significant difference in the levels of either ICAM-1 or IL-1β were found between patients using acetate and bicarbonate dialysate.

Conclusion: the bioincompatibility of the membrane is the important factor in the occurrence of the acute reaction during hemodialysis.

EL-Hefeni S, *Moghazy T*, Ragab M, and Khalil E* Chemical Pathology and *Nephrology Department Medical Research Institute, University of Alexandria, Egypt.

## Assessment of Patient and Dialysis-Related Factors Associated with Hepatitis B Vaccine Response

The CDC recommends that all hemodialysis (HD) patients receive the hepatitis B vaccine (HBV). Response to HBV in HD patients is less than that in healthy adults and antibody to hepatitis B surface antigen (anti-HBs) levels persist for shorter periods. Reported HBV response rates among HD patients range from 34% to 88%.

Objective: To identify patient-specific factors that may be associated with HBV response in HD patients. Methods: A HBV protocol was initiated at our center in 1999 and patients ($n = 134$) without a protective anti-HBs titer ($< 10$ mIU/mL) received recombinant HBV 40 mcg IM at 0, 1 and 6 months. Anti-HBs titers were monitored quarterly and booster doses were given when indicated. This retrospective cohort study included adult HD patients with sufficient seroconversion data at 12 and 24 months post-HBV vaccination. Non-paired student's *t* test was used to test for differences in mean age, serum albumin, and eKt/V between HBV responders (anti-HBs $\geq 10$ mIU/mL) and non-responders at 12 and 24 months post-vaccination. Chi-square analysis was performed to test for differences in gender and the prevalence of diabetes mellitus (DM) at the same intervals.

Results: Overall HBV response was 36.4% ($n = 66$) and 37.5% ($n = 40$) at 12 and 24 months, respectively. No statistically significant differences in age, gender, serum albumin, or eKt/V were observed between responders and non-responders at 12 and 24 months. There was no difference in the prevalence of DM at 12 months. At 24 months, 9/15 (60%) responders had DM compared to 6/25 (24%) non-responders ($p \leq 0.025$). This finding was unexpected and may be a statistical aberration resulting from inadequacies in study design and sample size. Of note is the disparity between the initial number of patients and the number included in these analyses, which is due primarily to patient turnover and subsequent loss of follow-up.

Conclusion: Long-term HBV response rates in our HD patients were similar to those previously reported. Larger prospective studies would be needed to confirm the finding that patients with DM had superior HBV response.

*Elwell R.J.*[1], Neumann M.[2], Bailie G.R.[1]. [1]Albany College of Pharmacy, Albany, NY. [2]Albany Dialysis Center, Albany, NY, USA.

## Efficacy of Hepatitis B Immunization in HIV-Infected Patients on Hemodialysis (HD)

Patients on HD are at a high risk of hepatitis B infection. Therefore hepatitis B vaccination is recommended for all HD patients, although compared with adults with normal immune status, the protective antibody response is lower and ranges from 34–88%. We hypothesized that HIV infected patients on HD are likely to have even lower antibody responses to hepatitis B vaccination. We therefore reviewed the immunization history of 16 HIV-infected

dialysis patients who received chronic maintenance HD at our dialysis units. The mean age of the patients was $43 \pm 11$ (mean $\pm$ SD). Of the 16 patients the majority were black males (13). The mean CD 4 count of these patients was $261 \pm 206$ (mean $\pm$ SD, range: 18–668 cells/$\mu$L). The mean viral load was $96727 \pm 184084$ (range 50–650846 copies/ml). Six patients had undetectable plasma viral loads. Of the 16 patients, 10 had protective antibodies (HBs Ab $\geq$ 10 mIU/ml). Of these 10 patients, 3 had positive Hepatitis core antibody suggesting previous viral exposure, another 3 were negative for HBcAb and in the remaining 4 HBcAb was unavailable. Five of the 10 patients with protective antibody received vaccination after starting dialysis. Pearson product moment correlation showed negative correlation of HBsAb with viral load, $r = -0.45$, p value $= 0.07$. No correlation was found between CD4 count and response to vaccination. We conclude that HIV-infected HD patients develop protective antibodies at a rate similar to HIV-negative HD patients.

Fahlen M, Vu H, Ahuja TS. University of Texas Medical Branch, Galveston, TX, USA

## *Infection*

### Hepatitis B Vaccination Responders vs. Non-responders on Hemodialysis: Baseline Patient Characteristics

Vaccination of Hemodialysis (HD) patients for the Hepatitis B virus is recommended. However, the rate of seroconversion at 30–75% is lower than that of the general population at 90 + %. In prior dialysis studies, younger patient age predicted seroconversion. **Objective**: To analyze baseline characteristics of HD patients with different vaccination responses. **Method**: A retrospective analysis of 2 distinct groups of HD patients: Group 1 (responders) seroconverted after 1 series of standard Hep B vaccination (40 mcg IM at 0,1,6 mos.), Group 2 (non-responders) failed to convert after 3 such series. All subjects were Hepatitis B & C Ab (-) at the start of HD. These two groups were compared in their age, sex, race, laboratory values, cause of renal failure, access type, nPCR, Kt/V at the initiation of HD to determine which factors may have predicted vaccination response. **Results**: 78 patients were identified as responders, 30 patients as non-responders. By univariate analysis, baseline lab tests did not differ for: WBC, albumin, phosphorous, calcium, intact PTH, ferritin, total iron, or HCT. The groups did not differ in racial mix or male:female ratio. Access type did not differ, averaging 60% catheter use at start of HD.

| *Variable* | *responder* | *non-responder* | *p* |
|---|---|---|---|
| Diabetes | 29% | 79% | .040 |
| Age (avg. $\pm$ SEM) | $50 \pm 1.8$ | $57 \pm 2.5$ | .041 |
| Wt. (kg) | 69 | 79 | .023 |

The groups differed in average age, prevalence of diabetes and weight (Table). Responders had a significantly lower serum bicarbonate (20 meq/L vs. 23 meq/L, $P = .040$), though nPCR and Kt/V did not differ. **Conclusion**: HD patients who failed to responded to the Hep B vaccination after 3 series were older, more likely to be diabetics and weighed more than those who did respond after only 1 vaccination series. The responders were slightly more acidotic, though there were no differences in nPCR or serum albumin.

*Chin AI*, Division of Nephrology, University of California at Davis, Sacramento, CA, USA

### Access-related Infection and Pre-infection Albumin in Hemodialysis

Infection of hemodialysis (HD) access is a major cause of morbidity and mortality. Certain conditions predisposing to infection (malnutrition, chronic inflammation) are associated with hypoalbuminemia. To test whether pre-existing hypoalbuminemia has any relationship with HD access infections, we analyzed the records of 87 patients on chronic HD who had access-related infection as the reason for hospital admission between July 1999 and June 2001. We obtained data on age, gender, pre-infection albumin levels, co-morbidities, complications, type of infection, infecting organism, mode of management and mortality. We compared average pre-infection albumin levels of 79 patients with access infection with those of 198 control patients on chronic HD during the study period without documented access infection. We also compared mortalities between patients with HD tunneled catheter infection treated with antibiotics alone and those treated with antibiotics plus access removal. The mean pre-infection serum albumin was lower in subjects with access infection than those without access infection ($2.4 \pm 0.6$ vs. $3.2 \pm 0.6$ g/dL, $P < 0.0001$). Logistic regression including several clinical confounders among its candidate variables identified hypoalbuminemia as a strong predictor ($P < 0.0001$) of access infection. The odds ratio (OR) of access infection increased progressively with decreasing pre-infection serum albumin: OR of access infection was 8.0 (95% confidence interval {CI} 4.5–16.6) for albumin $\leq$ 3.0 g/L, 11.0 (95% CI 4.4–22.3) for albumin $\leq$ 2.5 g/dL, and 27.9 (95% CI 6.1–128.1) for albumin $\leq$ 2.0 g/dL. Women had a marginally higher chance of tunneled HD catheter infection than men ($P = 0.08$). Case mortality was 25% (4 in 16) in patients with tunneled HD catheter infection treated with antibiotics alone and 2.8% (2 in 71) in those treated with antibiotics plus access removal or change over a guide wire ($P = 0.0096$). Hypoalbuminemia, a predictor of adverse outcomes in HD, is associated with an increased risk of HD access infection. Women with tunneled HD catheter have a tendency to higher rates of access infection than men. Treatment of tunneled HD catheter infection with antibiotics alone is associated with increased risk of death.

Adeniyi OA, *Tzamaloukas AH.* St Agnes Health Care, Baltimore, MD, USA, New Mexico VA Health Care System and University of New Mexico, Albuquerque, NM, USA

## Unusual Pathogens Causing Cellulitis and Bacteremia in Hemodialysis Patients

Cellulitis in immunocompetent hosts is usually caused by skin organisms and responds to oral antibiotics. In immunocompromised hosts, such as End-Stage Renal Disease (ESRD) patients, unusual organisms with variable pathogenicity can cause infections. We present two cases with isolates that are usually encountered in coastal waters. Case 1. A 71-year old African-American ESRD patient presented with a painful lesion on the right leg for 3 weeks, and fever and chills for 2 days. He sustained a right leg wound 4 weeks prior to presentation. During that period a tropical storm flooded his house contaminating his open wound with salt water. He had a 3 cm erythematous and tender ulcer on his right leg. Blood cultures grew *Vibrio alginolyticus*. He was successfully treated with a 4-week course of Gentamicin. Case 2. A 70 year-old Caucasian male ESRD patient presented with severe tenderness and erythema of his left forearm after an injury on a shrimp boat 10 hours prior to presentation. He was hypotensive, febrile, and required intensive care for vasopressor support and intravenous antibiotics. His blood cultures grew *Vibrio vulnificus* and he was treated successfully with doxycyclin and ceftazidime.

Vibrio species are halophilic marine gram-negative bacteria. *Vibrio alginolyticus* was the causative agent of cellulitis and bacteremia in our first hemodialysis patient, who was exposed to flood waters. *V. alginolyticus*, a non-lactose fermenting gram-negative bacillus, has rarely been isolated from blood. *Vibrio vulnificus* was isolated from our first patient presenting with cellulitis and subsequent septicemia. *V. vulnificus* belongs to the lactose positive vibrio group, which is likely to produce severe localized or systemic disease. Both patients were successfully treated with appropriate antibiotics after obtaining the antibiotic sensitivities. In both cases, the common features were immunosuppression and exposure to marine environments. These two cases of life-threatening cellulitis and bacteremia are presented as an example of environmental pathogens common to a selected environment, i.e., marine vibrio species, and the imperative need of rapid identification and treatment in immunocompromised hosts.

*Ruiz CC*, Agraharkar M. Department of Internal Medicine, Nephrology Division, University of Texas Medical Branch, Galveston, TX, USA.

## On the Influence of the Risk of Virus Infections by Heat Sanitization of the PHD Hemodialysis Equipment

Virus infections, particularly the hepatitis viruses and HIV are constant threats to dialysis patients. There are no studies of the influence of heat sanitization of dialysis equipment. When multiple patients use a dialysis machine, the possibility of human blood-borne virus transmission exists. To assure the safety of the PHD we studied inactivation of several logs of viral infectivity, by the PHD disinfection process.

Methods: Heated RO water was spiked with model viruses at $75°C \pm 1°C$ and $82°C \pm 2°C$ for 0, 20 and 45 minutes. As model viruses we used bovine viral diarrhea virus (BVDV) Ñ model for hepatitis C, hepatitis A virus (HAV), and porcine parvovirus (PPV). PPV is very robust and resistant to heat sanitaization procedures and served as the model for Hep-B and HIV that cannot be used in vitro studies.

Results: 75C treatment instantaneously reduced the BVDVviral titer to non-detectable levels. HAV, one of the most robust viruses evaluated in viral clearance studies, was also reduced to non-detectable levels within 20 minutes. The PPV titer was reduced by approximately 5 log10 within 45 minutes. At $82°C \pm 2°C$, PPV was reduced to non-detectable levels within 20 minutes. Given that parvoviruses are the most robust viruses evaluated to date in viral clearance studies, the true potential of the treatment step to inactivate viruses is much greater than can be demonstrated.

Conclusions: The heat treatment used by the PHD is very ''robust''. Given that this study was performed at reduced temperature and time and that the typical PHD System disinfection temperature is $85°C \pm 5°C$ for 1 hour, the convincing log10 reduction values for PPV not only demonstrate the safety of the PHD heat sanitization presently, but also provide a strong indication that the treatment will also inactivate other currently unknown viruses.

Grushevsky A, *Kjellstrand C*, Aksys, Ltd., Lincolnshire, IL, USA.

## Effects of Oral Nutritional Supplementation on Nutritional Status in Chronic Hemodialysis Patients

Protein-calorie malnutrition is common in chronic hemodialysis (CHD) patients and is associated with poor outcome. Very few studies of oral nutritional supplementation have been conducted and these have shown mixed results. Objective : To evaluate nutritional status in our CHD patients receiving oral nutritional supplementation over a period of 6 months. Methods : 22 CHD patients with evidence of malnutrition were included in this prospective study. The inclusion criteria were serum albumin of $\leq 3.5$ g/dL or serum prealbumin of $\leq 30$ mg/dL and a decrease of dry weight $\geq 5\%$ in the last 3 months or $\geq 10\%$ in the last 6 months. Patients received nutrition intervention by various oral nutritional supplements providing 450 calories and 15.4 grams of protein per day. Compliance was assessed by questioning patients at each HD session. Nutritional parameters were recorded and results were analyzed using paired *t* test to examine the difference between compliant and non-compliant patients for each nutritional parameter at baselines and 6-month follow-up.

Results : 10 patients were considered as non-compliant because ingesting $< 75\%$ of prescribed nutritional supplementation. In compliant patients, there were significant increases in concentrations of serum albumin ($3.14 \pm 0.72$ vs $3.57 \pm 0.95$ g/dL, $p < 0.01$), serum prealbumin ($24.7 \pm 6.3$ vs $29.5 \pm 4.7$ mg/dL, $p < 0.01$) and of the estimated dry

weight ($64.2 \pm 8.5$ vs $67.9 \pm 6.1$ kg, $p < 0.05$). There was not any significant modification of nutritional markers in non-compliant patients. Dietary intake estimated by dietary recall was unchanged during the study in all patients.

Conclusions : When observed, oral nutritional supplementation is effective to improve nutritional markers in malnourished CHD patients. Limits of this intervention are weariness and non-compliance over time.

*Azar R.*, Jean F., Carru V., Clicteur K., Bryche O. Dept of Nephrology, Dunkerque General Hospital, Dunkerque, France.

## Amino Acid Transport Kinetics and Protein Turnover in Hemodialysis

**Background**: Protein metabolism is abnormal in patients with end-stage renal disease. However, the etiology of abnormal protein turnover is unclear. Also the role of hemodialysis on protein turnover remains controversial. Abnormal protein metabolism could be due to malnutrition or due to abnormal amino acid transport kinetics

Hypothesis: 1) Amino acid transport is abnormal in uremia, 2) Hemodialysis increases fractional protein synthesis rate and c) Net protein accretion is negative during hemodialysis because of increased catabolism.

**Aim**: 1) To study the impact of uremia and hemodialysis on intracellular amino acid transport kinetics and 2) Quantify the fractional protein synthesis rate and degradation in a uremic state and during hemodialysis

**Methods**: Protein turnover and amino acid transport kinetics using stable isotopes of phenylalanine in 2 patients and 2 controls. The patients were placed on a standard diet (1.2 gm/Kg protein and 35 Kcal/Kg) for 2 weeks prior to the study. Acidosis as corrected by $NaHCO_3$ supplementation. Amino acid transport and protein turnover were estimated by compartmental model and precursor product approach respectively.

**Results**: Mean protein intake and HCO3 were $1.4 \pm 1$ gm/day and $26.8 \pm 4.1$ meq/L respectively. Inward transport ($11.2 \pm 2.6$ vs. $9.8 \pm 2.1$ nmol/min$^{-1}$/100 ml leg$^{-1}$) and outward transport ($10.2 \pm 1.2$ vs.$11.0 \pm 1.61$ nmol/min$^{-1}$/100 ml leg$^{-1}$) were not different before and during HD. Inward and outward transport in controls were $12.6 \pm 3.7$ and $16.2 \pm 3.5$ nmol/min$^{-1}$/100 ml leg$^{-1}$ respectively. Protein synthesis was higher than catabolism in the pre-dialysis phase ($156.8 \pm 66.1$ vs. $144.3 \pm 53.7$ nmol/min/ml leg-1, p = NS), but catabolism was higher than synthesis during HD ($172.3 \pm 20.5$ vs. $186.8 \pm 25.8$ nmol/min/ml leg-1, p = NS). Protein synthesis and catabolism in controls were $110.8 \pm 13.5$ and $127.4 \pm 12.7$ nmol/min/ml leg-1.

**Conclusion**: 1. Inward and outward transport of amino acids are not altered by renal failure or hemodialysis. 2. Protein turnover is increased during hemodialysis, with net balance favoring catabolism

Dominic Raj, Pedro Blandon, Arny Ferrando, Oladipo Adeniyi, Vallabh Shah, Chris Stidley, Robert Wolfe, Philip Zager. Division of Nephrology, University of New Mexico, Albuquerque, NM, USA.

## Factors Influencing the Parathyroid Hormone Response in Hemodialysis Patients

PURPOSE OF STUDY: Adynamic bone disease (ABD) indicates a significant risk factor for morbidity and mortality, therefore risk factors for ABD should be investigated. In this study we aimed to determine the contributing factors for ABD and parathyroid hormone (iPTH) response in HD patients.

METHODS: A series of 139 patients (age: $47.8 \pm 13.8$ years, HD duration: $67.1 \pm 52.7$ months) were included. Five years data about the patients clinical therapy and cumulative calcium dose) and laboratory features were collected. Patients were divided into three groups as those with low, intermediate and high iPTH: Group I (iPTH<150 pg/ml, n:43), Group II (iPTH: 150–300 pg/ml, n:37) and Group III (iPTH: > 300 pg/ml n:59). We excluded the patients who received calcitriol therapy after the initiation of HD from group I.

RESULTS: When the groups were compared, patients in-group I had significantly shorter HD duration ($54.5 \pm 40.1$ and $72.8 \pm 54.3$ months, $p < 0.04$), higher mean calcium and lower phosphorus levels ($p < 0.0001$, $p < 0.0001$), higher total cholesterol ($p < 0.001$), CRP ($p < 0.02$), fibrinogen ($p < 0.005$), and ferritin ($p < 0.01$) levels than those in-group II and III. A higher calcium phosphorus product ($44.7 \pm 12.5$ and $50.9 \pm 12.4$, $p < 0.0005$) and presence of rHuepo resistance ($p < 0.003$) were strikingly different between Group II and III. According to the multivariate analysis, follow-up data of higher calcium ($p < 0.0001$) and fibrinogen ($p < 0.03$); lower phosphorus ($p < 0.001$) levels were significant determinants of low PTH levels.

CONCLUSION: Even small changes in calcium phosphorus balance can influence a wide spectrum of parathyroid hormone response in long-term follow-up. Underlying inflammation is an additional risk factor for the development of adynamic bone disease, which could explain the potential co-morbidity of this clinical condition.

*Z. Arat*, S. Sezer, F.N. Ozdemir, E. Kulah, B. Budak, M. Turan, M. Haberal. Baskent University Faculty of Medicine, Dept. of Nephrology, Ankara, Turkey.

## Gene Expression Analysis in Inflamed and Non-inflamed Hemodialysis (HD) Patients Using a cDNA Microarray

Systemic inflammation is an independent predictor of mortality in HD patients, and a better understanding of its pathogenetic pathways and identification of targets for intervention are needed. The cDNA microarray technology has recently been used to profile gene expression, and examines simultaneously a broad variety of genes that could

determine biological and pathogenetic processes. To investigate the gene expression profile in white blood cells of eight persistently inflamed (CRP > 10 mg/L for 12 months) HD patients compared to eight non-inflamed patients (CRP < 10 mg/L for 12 months), we designed a pilot study using a cytokine expression array (R&D Systems), including 398 different cloned cDNAs, printed as PCR products, on a positively charged nylon membrane. mRNA was extracted from leucocytes and pooled for each group, which were matched for age, gender, primary renal disease, and time on HD. Comparison of the signals from the two samples allowed identification of differentially expressed mRNA. A 10x increase in mRNA expression between the groups was defined as up-regulation. The results showed that 32 genes were up-regulated in the inflamed group compared to the non-inflamed group. Highly up-regulated genes belonged to the following groups: members of the TGF-β superfamily (5 genes), proteolytic enzymes (5), integrin (4), genes involved in nitric oxide metabolism (3), TNF superfamily (3), interleukin receptors (3), cell surface proteins (2), orphan receptors (2), neurothrophic factor (1), fibroblast growth factor family (1), cytokine receptor (1), cytokine (1), and chemokine (1). In conclusion, circulating lymphocytes of inflamed HD patients had markedly up-regulated expression of inflammation-related genes, providing a molecular fingerprint of gene function on the RNA level. These genes should be considered as candidates for genotype analysis or targets for intervention studies.

*Pecoits-Filho R*, Hauzenberger D, Stenvinkel P, Heimbürger O., Seeberger A., Nordfors L., Lindholm B. Div. of Baxter Novum and Renal Medicine, Dept. of Clinical Immunology, and Center for Molecular Medicine, Karolinska Institutet, Stockholm, Sweden.

## Matrix Metalloproteinase-3 and Nutrition in HD-Patients with Dialysis-related Amyloidosis.

Matrix Metalloproteinase-3 (MMP-3) has been linked to articular destruction in rheumatic arthritis. In order to examine the clinical disease activity of HD-related amyloidosis, we measured circulating MMP-3 of HD patients with post-operative carpal tunnel syndrome (CTS). Moreover, for evaluation of nutritional status, we measured mid-arm circumstance (MAC) and the ratio of extra-cellular fluid (ECF) to total body water (TBW) by a bioimpedence method. 8 patients (5M/3F) with CTS were suffering from arthralgia and emaciation, mean age 58.2(51–72), treated for an average of 23.6 years (14–31). Levels of serum MMP-3 were determined by enzyme-linked immunoassays. In other randomized 11 HD patients (7 M/4F), pre-dialysis levels of MMP-3 & IL-6 were measured together for examining the relationship between MMP-3 and IL-6. In the amyloidosis group, MMP-3 showed remarkably high levels of 558 ng/ml (227–1090). MAC and ECF/TBW ratio were 91.9% (83–102) and 0.364 (0.344–0.375), respectively. More than half of patients with arthralgia showed decreased MAC and excessive extra-cellular fluids. In the randomized group, MMP-3 and IL-6 were correlated positively each other ($p = 0.0082$).

Conclusively, patients with the clinical disease activity of HD-related amyloidosis have high levels of MMP-3 and protein energy malnutrition. IL-6 may mediate increase of MMP-3 and malnutrition.

*Makoto I*, Tomohito M, Kuniaki A, Eishi M. Kidney Center, Eijinkai Hospital, Furukawa, Miyagi, Japan.

## Methylmalonic Acid in Dialysis Patients

Propionyl-CoA is a common product of metabolism of essential AA (Val, Thr, Leu, Ile), fatty acids and cholesterol and is further metabolised enzymatically to methyl-malonyl CoA, which is further isomerised to succinyl CoA. Because of the common cofactor (cobalamin) methylmalonic acid (Mma) can serve as an early marker of functional cobalamin deficiency.

*Purpose of the study*: To evaluate possible hidden cobalamin deficiency and the effect of treatment with iv. vit B12 on Mma and tot. homocystein (tHcy) levels in dialysis patients (pts).

*Methods*: 48 HD treated pts, in routine medication folic acid 5 mg/d, pyridoxin 20 mg/d. Measurement of serum levels of Mmk, folic acid, tHcy, cobalamin, blood counts. Healthy patients served as controls for Mma. Vit B12 therapy – cyanocobalamin 1 mg iv. after HD every week for 6 weeks, after 6 weeks 1mg monthly.

*Results*:

| *HD patients:* | *before B12 treatment* | *after B12* |
|---|---|---|
| Methylmalonic acid | 0,904 +/− 0,389 | 0,554 +/− 0,222 |
| Total homocystein | 21,653 +/− 6,851 | 16,055 +/− 4,896 |
| Mma in EPO treated pts: | 0,842 +/− 0,325 | 0,536 +/− 0,234 |
| Mma in EPO non-treated: | 1,028 +/− 0,482 | 0,590 +/− 0,199 |

Healthy controls: Mma = 0,305 +/− 0,158 umol/l (max. norm. 0,22)

*Conclusions*: We did not find overt vitamin B12 deficiency in HD pts, however elevated levels of Mma and tHcy raise a question about functional B12 deficiency. Vitamin B12 supplementation improved (decreased) the levels of both methylmalonic acid and homocystein in this subset of patients. Influence of EPO treatment merits further study.

*Svoboda L.*, Stráník L., Hyánek J., Pehal F. Hospital Na Homolce, Prague, Czech Republic.

## Nocturnal Home Hemodialysis: Focus on the Partner

**Background**. Nocturnal home hemodialysis (NHD, 6 times weekly 6–8 hours) results in a better clinical and psychosocial condition of dialysis patients. However, this intensive therapy has important consequences for partners,

who bear at least some responsibilities during the treatment. **Methods**. Since December 2001, we included 15 patients in a Dutch NHD project ('Nocturne'). All patients are assisted by their spouses. An aim of Nocturne is to study the effects of NHD on partners and other family members with questionnaires and interviews by a social worker. **Results**. NHD affects daily life of partners much more than conventional therapies. Partners feel very involved with the treatment. The invasion of the treatment in bed, the noise and light produced by the machine, the daily assisting of the patient, less freedom, and co-responsibility for the treatment are felt as a burden, specially during the first months of the treatment. However, the improved clinical condition of their spouse, resulting in less fatigue, less disability, less uremic symptoms, less complications, more attention for and contribution to family life, better quality of life and better mood are considered major improvements, with important positive effects for the quality of life of all family members. Additionally, partners consider the fact that they make an important positive contribution to their spouse's health valuable. All partners judged NHD, despite some negative consequences, as a major improvement of their life. **Conclusion**. The positive effects of NHD are more important than the negative consequences for partners of patients. However, partners need active support by nurses or social workers, specially during the first months of the treatment.

*Vos H*, Stokvis SJA, Verhallen A, Kooistra MP.Dianet Dialysis Centres, Utrecht, The Netherlands.

## The Burden of Self-Dialysis: Opinion From Patient's Side

Non-compliance is crucial in chronic diseases and increases with complexity of therapies. **Objective and methods**: to build and validate, in a pilot study involving home and self-limited hemodialysis (HD) patients, a questionnaire assessing dialysis related discomfort (12 items, 4 fields: support therapies, time requirements, relationship with hospital-machine, dialysis related discomfort) and the advantages of flexible schedules and simplified therapies (6 items). A 0–10 visual analogue scale was employed. **Results**. The study was completed by 50/52 (96%) patients on home or self-limited care HD in a satellite Unit: median age 50 yrs (24–80), follow-up 40 mths (2–360); therapy: 10 pills/day (2–24), 2 subcutaneous injections/week (2–30). The highest scores, describing discomfort, were recorded for: time requirements (median score 8/10), dependence upon the machine (7/10), needle punctures (6/10), drug therapy, vascular access and dependence upon others (5/10). The option of flexible schedules and simplified support therapies obtained maximal scores (median 10/10). No relationship among single scores, clinical data, dialysis or support therapy was found. According to the pattern of the answers, patients were grouped into three main profiles (attitude towards dialysis related problems): stoic (20 cases), suffering (11) and selective (19). No correlation with clinical data and profile was found. **Conclusion**. Support therapies and organizational aspects cause important discomfort to our dialysis patients. Further studies in different cohorts are needed to define them, to optimize treatment acceptance and compliance.

*Soragna Giorgio*, Mezza Elisabetta, Bermond Francesca, Longo Patrizia., Talaia Marinella, Bianchi Valeria, Jeantet Alberto, Segoloni Giuseppe Paolo. Department of Nephrology, Ospedale Molinette, University of Turin, Turin, Italy.

## Nocturnal Hemodialysis Improves Productivity of End-Stage Renal Failure Patients

*Background*: End-stage renal disease (ESRD) patients undergoing conventional in-center hemodialysis (CHD) [3 sessions per week, 4 hours/session] have poor productivity which often results in unemployment. Nocturnal hemodialysis (NHD) [5–6 sessions per week, 8hours/session] is a novel home-based renal replacement therapy, which has been shown to have significant clinical improvements; including: blood pressure control, regression of left ventricular (LV) hypertrophy and restoration of impaired LV systolic function. The objective of our current study is to examine the impact of NHD on the productivity of ESRD patients before and after conversion from CHD to NHD.

*Methods*: We conducted a retrospective survey of all NHD patients ($n = 26$) at the Toronto General Hospital, University Heath Network from May 1999 to Dec 2001. The parameters examined included (1. duration of NHD, 2. employment status, and 3. hours of productivity) before and after conversion from CHD to NHD. Paired Student t-Test was used to detect statistical significance.

*Results*: Twenty-six patients (age:$40 \pm 10$; mean $\pm$ SD) were included in our study. The mean duration of NHD in our cohort was $1.7 \pm 0.9$ years. Although, employment status were similar before and after conversion to NHD (CHD: 20/26 versus NHD: 21/26), there was a significant increase in the hours of productivity, CHD: $27.4 \pm 18$ hours per week versus NHD: $36.9 \pm 21.7$; $p = 0.006$.

*Conclusion*: NHD is associated with a significant improvement in productivity in ESRD patients. NHD may be the modality of choice to restore ESRD patients the ability to pursue a normal lifestyle.

*Faratro R*, and Chan CT. University Health Network, Toronto General Hospital, Toronto, Ontario, Canada.

## Perceived Exercise Benefits and Barriers in Hemodialysis Patients

**Purpose**: Exercise participation in hemodialysis centers remains low despite the opportunity, equipment, and proven benefits. The purpose of this study was to measure the perceived benefits and perceived barriers to exercise participation. **Methods**: A questionnaire using the Exercise

Benefits/Barriers Scale was administered to 150 in-center, chronic hemodialysis patients at a free standing dialysis center with an ongoing exercise program for three years. This survey was adapted to show the patients' perceived benefits and barriers of exercise in the dialysis unit. **Results**: The overall score of the unit (n = 150) was 92.0 ± 12.2 with a possible range from 31 to 124. Exercisers (n = 32) had a mean of 98.1 ± 12.3 on the scale; non-exercisers (n = 118) had a mean on 90.4 ± 11.7 ($p < .05$). Answers to 12 of the 31 questions were significant ($p < .05$). Seven questions were perceived benefits; five questions were perceived barriers.

| | *All (n = 150)* *Mean* | *Non Exercisers (n = 118)* *Mean* | *Exercisers (n = 32)* *Mean* |
|---|---|---|---|
| **Exercise Benefits/Barriers Scale** | 92 ± 12.2 | 90.4 ± 11.7 | 98.1 ± 12.3 |
| Benefits | 62.1 ± 10.2 | 61.2 ± 9.8 | 65.3 ± 11.0 |
| Barriers | 29.6 ± 4.6 | 28.8 ± 4.6 | 32.9 ± 3.2 |
| *Questions with p < .05* | | | |
| Enjoy exercise | 3.0 ± 0.7 | 2.7 ± 0.9 | 3.4 ± 0.6 |
| Prevent heart attacks | 3.3 ± 0.6 | 2.9 ± 0.8 | 3.4 ± 0.6 |
| Improve cardiovascular system | 3.1 ± 0.7 | 3.1 ± 0.7 | 3.4 ± 0.6 |
| Difficult due to vision | 3.3 ± 0.8 | 3.3 ± 0.8 | 3.7 ± 0.5 |
| Difficult due to arthritis | 2.9 ± 1.0 | 2.8 ± 1.0 | 3.6 ± 0.6 |
| Takes too much time | 3.0 ± 0.7 | 2.9 ± 0.7 | 3.3 ± 0.6 |
| Boring | 3.3 ± 0.6 | 3.0 ± 0.8 | 3.3 ± 0.7 |
| Increase physical fitness | 3.2 ± 0.6 | 3.0 ± 0.6 | 3.3 ± 0.6 |
| Increase stamina | 3.2 ± 0.6 | 3.1 ± 0.5 | 3.4 ± 0.7 |
| Family does not encourage | 2.7 ± 0.9 | 2.7 ± 0.9 | 3.1 ± 0.8 |
| Carry out activities without tiring | 3.0 ± 0.7 | 2.9 ± 0.7 | 3.2 ± 0.7 |
| Improve body function | 2.9 ± 0.7 | 2.8 ± 0.7 | 3.1 ± 0.7 |

**Conclusion**: Physical improvement was the main reason to exercise. Lack of desire and health problems were the chief reasons named for not exercising. Addressing the benefits and barriers may improve exercise participation among chronic hemodialysis patients.

*Fondahn E.*, Hahn H., Schnitzler M.A., Miller B.W. Renal Division, Washington University, St. Louis, MO, USA.

## Depression Levels Before and After Renal Transplantation with Chronic Rejection

PURPOSE OF STUDY: Psychosocial parameters are closely related with the physical well-being of ESRD and renal transplantation patients. Additionally, depression has also been increasingly recognized among this group of patients. Our aim in this study was to compare the presence and stage of depression and the confounding parameters in renal transplant recipients and the patients on dialysis therapy.

METHODS: Our study included 88 patients (62M/26F, age: 31.1 ± 11.7 years) who were divided into 3 groups: renal transplant recipients (Group I, n = 27), renal transplant waiting list patients (Group II, n = 30) and chronic allograft rejection patients on dialysis therapy (Group III, n = 31). Age, gender, marital status, presence of chronic rejection, duration of transplantation and HD were retrieved from the patient records. Beck Depression Inventory was administrated to each patient by the same psychologist. No acutely interfering illness was present at the time when the test was given.

RESULTS: The depression incidence and stage of group I and group III were significantly different ($p < 0{,}003$). Although the depression presence and stage was not related with age and gender of the patients, interestingly we observed that it was lower in married patients ($p < 0{,}03$). Also there was an inverse correlation between presence and stage of depression and functional graft duration in chronic rejection patients on HD therapy ($r = -0{,}370$; $p = 0{,}04$).

CONCLUSION: After returning back to HD after chronic rejection, the patients had higher levels of depression. Sharing the physical and psychological problems with another person decreased the depression in married patients; therefore higher social and psychological support must be given to the patients after chronic rejection especially to the single ones.

B. Akman, F.N. Ozdemir, S. Sezer, H. Micozkadioglu, M. Haberal. Baskent University Faculty of Medicine, Dept. of Nephrology, Ankara, Turkey.

## Experiences on Home Hemodialysis without an Assistant

A program of home hemodialysis (HHD) was instituted at a University Hospital in 1998. In this study we evaluated experiences in training patients for HHD with and without an assistant.

So far we have trained 59 patients for HHD. All patients had either AV fistula (58 cases) or arteriovenous graft (1 case). In 1998–2000 only two of 32 patients were trained to perform HHD without an assistant. However, we have changed our training policy and in 2001 6 of 14 patients and in 2002 12 of 13 patient were trained to perform HHD without an assistant. The mean age of all patients with an assistant (n = 39) was 49.8 ± 11.9 years (mean ± SD), range 24 to 71 years. The assistant was spouse or other relative (36 cases), a friend (2 cases), or nurse (1 case). The mean age of patients without an assistant (n = 20) was 42.4 ± 14.2 years, range 18 to 64 years. Fourteen of the patients with an assistant continue on HHD. Drop outs (25 cases) were caused by renal transplantation (20 cases), death ( 3 cases), social and access problems (2 cases). Sixteen of the patients without an assistant continues on HHD. All drop outs were caused by renal transplantation (4 cases). So far 570 patient months have been performed in HHD by patients with an assistant and 115 patient months by patients without an assistant. The mean training time in 2002 was 4–5 weeks. We have had no major technical or medical complications in our home hemodialysis program in either training groups.

*Conclusions*: We have good experiences in training patients to perform home hemodialysis by themselves. Home

hemodialysis without an assistant allowed tailored and flexible dialysis schedule. Patients are independent and no family member is tied to the treatment. This program enables home hemodialysis also for those patients who live alone.

*Malmström Raija*, Muroma-Karttunen Riitta, Kilpiä Meeri, Honkanen Eero. Department of Medicine, Division of Nephrology, Helsinki University Central Hospital, Helsinki, Finland

## Dialysis or Transplantation for End-Stage Renal Disease in Adults? An Evidence-based Answer

The Evidence Based Medicine is a new approach looking for implementation in the academic teaching of Internal Medicine. **Objective**: to include this subject in our post-graduate medical school, in the curriculum and as a research project. **Methods**: since 2000, each year one of the post-graduate nephrology fellows starts a Cochrane revision with the tutorial help of Nephrologists and Methodologists. **Results**: two titles were accepted for inclusion within the Cochrane Library (''Haemodialysis frequency for end stage renal disease'' and ''Home versus in-centre haemodialysis for end stage renal disease'') and one protocol will be published in the 4th issue 2002. The main methodological and clinical point of the accepted protocol are: – explanation, in the background section, of the state of the art and of the reasons why to perform a systematic review in this field; – explicitation of criteria for including studies (study design, type of participants, type of interventions, outcome measures) and for assessing methodological quality of the studies; – elaboration of a sensible and reproducible search strategy aimed to identified any relevant article (even not published) seeking electronic bibliographic databanks (MEDLINE, EMBASE, CIHNAL), patients' websites and ESRD registries (*www.renalnet.com, www.kidney.org*); – identification of any sources of heterogeneity between studies; – elaboration of statistical analysis using a specific and validated program (Rev.Man) tailored for testing for heterogeneity and for combining data related to the identified studies in a metanalysis when appropriate. **Conclusion**: the direct involvement of the post-graduate Nephrology school in the systematic reviews is a precious didactic tool.

*E Mezza*, G Grassi, F Faggiano, F Bermond, M Calderini, D Sampo', L Gentile, GB Piccoli. Department of Nephrology, University of Torino, Italy.

## CVVHD in Pediatrics Multiorgan Dysfunction Syndrome: Bicarbonate-Based Solutions are Feasible and Safe

*OBJECTIVE*: To describe continuous veno-venous hemodiafiltration (CVVHD) procedure in a pediatric critical care unit using bicarbonate-based solution.

*PATIENTS AND METHODS*: From 06-2001 to 08-2002, nine patients were treated by CVVHD, age range 1,7–16 yrs, body weight 9,3–45 kg. Indications criteria: oligoanuria and hypevolemia, hemodynamic instability and impossibility of peritoneal dialysis. The patients' primary diseases were: policystic kidney disease (1/9), SLE (1/9), liver disease (6/9), mediastinal germ cells tumos (1/9). All patients were on mechanical ventilation and on vasopressos support. Pancytopenia was diagnosed in 9/9, and hepatic dysfunction in 8/9 pts.

The CVVHD prescription was: blood flow rate: 2–4 ml/min, dialisate and replacement flow rate: 2000 ml/1,73m2/h. Systemic heparin anticoagulation could not be used, and citrate regional anticoagulation (4% trissodium citrate) was used in a patient with normal hepatic function. The duration of procedures was 4–72 hours, and the total time range of CVVHD was 28 hours to 19 days. The solution was prepared in our hospital pharmacy. Prisma system (GAMBRO) and poliacrylonitrile M-60 hemofilter was used in all patients.

*RESULTS*: CVVHD was effective to control fluid balance and metabolic derangements. Anaphylactoid reaction was observed in one patient. Six patients died of causes other than renal failure (sepsis in 5/6 pts, hepatic failure in 1/6 pts). Three patients are alive, two with normal renal function.

*CONCLUSION*: CVVHD with bicarbonate-based solutions is feasible and safe and allow metabolic and fluid control in critically ill pediatric patients.

Watanabe A, Troster EJ, Koch VHK. Instituto da Criança-HCFMUSP, São Paulo, Brazil.

## Pediatric Bone Marrow Transplant (BMT) Recipients with Acute Renal Failure (ARF): Assessment of an Algorithm to Prevent Fluid Overload including Early Initiation of Renal Replacement Therapy (RRT)

**Objective:** ARF with fluid overload (FO) occurs often in BMT recipients. We have demonstrated increasing %FO prior to CRRT initiation is associated with mortality in children with ARF. Based on these data, we devised a protocol for FO prevention in BMT pts with ARF. BMT pts with ARF and 5% FO were started on furosemide and low-dose dopamine. To allow for nutrition, medication and blood product administration, RRT was initiated for pts with $\geq$ 10% FO. We reviewed the course and outcome for pediatric BMT pts with ARF and fluid overload managed with this protocol. **Subjects:** Medical records of 29 BMT pts with 33 ARF episodes from Jan 99 to Jan 02 were reviewed. Mean pt age was 12.8 $\pm$ 5 yrs (2–23.5 yrs). **Outcome:** 14/29 (48%) pts survived an initial ARF episode. 0/4 pts survived a second ARF episode. 14/14 survivors (S) either maintained $\leq$10% FO during course or re-attained $\leq$10%FO with RRT treatment. Max %FO for S was 17%. 7/19 non-survivors (NS) were <10% FO at the time of death. 4/18 (22%) pts who received RRT (3 HD, 15 CRRT) survived. 2/15 (13%) CRRT pts survived. Mechanical ventilation, Pediatric Risk of Mortality score $\geq$10 at ICU admission and use of >1 pressors were associated with lower survival ($p < 0.05$). Neither GVHD nor septic shock correlated with survival.

| | *Survival* | *Non-Survival* | *p* |
|---|---|---|---|
| Euvolemia | 14/14 | 7/19 | <0.001 |
| RRT needed | 4/14 | 14/19 | <0.02 |
| Ventilation | 6/14 | 18/19 | <0.0001 |

**Conclusion:** Our data demonstrate that maintenance of euvolemia (%FO $\leq$10% is critical for S in BMT patients with ARF as all non-euvolemic pts died. We suggest that aggressive management with diuretics and earlier RRT initiation in pts not responsive to diuretics may improve BMT pt survival.

Michael, M, Goldstein, SL. Dept Pediatrics/Renal Division, Baylor College of Medicine, Houston, Texas, U.S.A.

*Clinical Experiences*

## In-Center Short Daily Dialysis and Children

When faced with the realization that peritoneal dialysis (PD) is no longer feasible, what are the options for a 12 year old girl with End Stage Renal Disease, who also has Insulin Dependent Diabetes Mellitus? Recognizing that daily dialysis is the superior choice, how would In-Center Short Daily Hemodialysis (SDHD) impact this child? What are the risks for children? What are the benefits? Do we follow conventional guidelines? How would this impact her family as they were already facing burnout?

There is significant evidence to support the improved outcomes for the adult dialysis patient on Short Daily/Nocturnal Dialysis. There is limited data available on outcomes for the pediatric hemodialysis population. After team and family meetings, SDHD, via permcath was initiated.

To provide daily structure for the child, the diabetic regimen and minimize loss of school time, dialysis starts at 0730 hours. Kt/v, URR measurements and non-invasive blood monitoring continues. During the last eight months, better nutrition, diabetic control, no peritonitis, less phosphate binders, dietary and fluid restrictions, have resulted in increased school attendance, better performance and decreased hospitalization. BP control remains an issue. The family has arranged to have drivers on certain weekdays. The stress and workload is much less. Family time has improved.

In conclusion, the bloodwork isn't always ideal and the BP is higher than we wish to see. Many questions still remain. However, the glow on her face as she describes getting to sleep in the top bunk, her latest sleepover and the "A" on her Math test has certainly influenced our decision to consider SDHD as the treatment of choice for our children requiring hemodialysis.

*McCallum TM*, Matsell DG, Grimmer J, Beisetzer B, Casier S, Sumpton J, El-Hawary A, Mantulak A. Children's Hospital of Western Ontario, London, Ontario, Canada.

## Use of NIMH for determination of dry weight and prevention of dialysis associated morbidity in children.

The majority of hemodialysis (HD) treatments incorporate a prescription for fluid removal targeted to a patients "dry" weight. Hypotension, cramps or headache often complicates fluid removal in children. The purpose of this study was to evaluate whether non-invasive blood volume monitoring by hematocrit could be used for the determination of dry weight and prevention of intra-dialytic complaints in children on chronic HD.

*Patients and methods*: 128 dialysis sessions in 16 patients, aged 3–17 years, were evaluated. Non-invasive monitoring of hematocrit (NIMH) (Crit-line$^{TM}$, HemaMetrics) was performed during the whole HD session and expressed as % $\Delta$ of blood volume (%BV$\Delta$).

*Results*: Changes in blood volume significantly correlated with the changes of patient's weight during hemodialysis treatments ($p = 0.001$). Thirty HD sessions were complicated by symptomatic hypotension in 12 patients.

Characteristics of uncomplicated and complicated HD.

| | *Uncomplicated* | *Complicated* | *P(t-test)* |
|---|---|---|---|
| Patient's age | 15±2.1 | 9.5±3.8 | 0.006 |
| Intradialytic weight gain (%) | 4.3±2.1 | 5±1.5 | ns |
| BP at start HD (mm Hg) | | | |
| Systolic | 124±13 | 120±13 | ns |
| Diastolic | 72±12 | 69±10 | ns |
| Halfway %BV$\Delta$ | −8.2±3.6 | −9.8±3.8 | 0.07 |

*Conclusion:* Changes in blood volume measured by Crit-line correlate with the changes of patient's weight during hemodialysis treatments. Complicated HD sessions were associated with lower halfway %BV$\Delta$. This indicates that NIMH might be useful for the determination of dry weight and for prevention of intra-dialytic morbidity in children by remodeling of the ultrafiltration profile.

E. Levtchenko[1], D. Creemers[2], D.v. Schaijk[1], I. Rijbroek[1], C. Schroder[2]. [1]Pediatric Nephrology, UMC Nijmegen, [2]Pediatric Nephrology, WKZ, Utrecht, The Netherlands.